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ABSTRACT

The Augmented Human Intellect (AHI) system is a computer-based system designed to store, structure, and retrieve textual information in a way congruent with the characteristics of the individual. It provides for the hierarchical ordering of information and for the manipulation of text through a system of cross-referencing, modification, and selective retrieval. The AHI system was tested to see if its use affected the behavior of individuals, groups, and organizations. The system was implemented in a government research laboratory where job task types included an assortment of information and management positions. Direct observations, interviews, and attitude surveys were used to assess the effect of the system. The text provides a description of the system, the study design and implementation, and the results; the appendixes include tabular data relating to sampling, questionnaire findings, and other results. (EMH)

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EVALUATION AND ANALYSIS OF AN AUGMENTED KNOWLEDGE WORKSHOP

Final Report For Phase I

James H. Bair

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FOREWORD

This evaluation-analysis was performed in-house, under Job Order No. 55810000, with the assistance of two consultants, Dr. George A. Borden, Pennsylvania State University, and Dr. David W. Conrath, University of Waterloo, Canada. The data analysis was performed by the Psychological Research Center, Syracuse University.

The first section of the report includes an introduction to the System technology, a general overview of related work, and hypotheses of expected findings. Section II outlines the methods and procedures; Section III contains detailed observations and experiences; Section IV discusses the results of the experimental attitude questionnaire; Section V includes an analysis of individual responses, proficiency testing results, and the communication tally data; and Section VI reviews the study in terms of the hypothesis and the validity of the conclusions, and presents recommendations for system implementation and further study.

This technical report has been reviewed and is approved.

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Section I
INTRODUCTION

Background

Computer technology has evolved with an almost incomprehensible rapidity over the past two decades. Applications of this technology have changed from purely numerical programs to solution of sophisticated scientific problems to manipulation and processing of natural language. The latter application has resulted in a man-computer symbiosis where the computer system becomes an extension of man's intellectual processes. In a now classic paper, J.C.R. Licklider (1968b) outlined the total system with man and computer as integral components. Parallel to the development of computer capability over the past decade has been the development of a system designed to take maximum advantage of the computer's power to store, structure and retrieve textual information in a way congruent with the characteristics of an individual.

Appropriately, the name given to this system was the Augmented Human Intellect System, developed under the leadership of Dr. Douglas Engelbart of the Stanford Research Institute. Originally, the purpose was to "...increase the capability of man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems." (Lindgren, 1971) This intention to provide an extension to man's intellect by utilizing a set of powerful computer based tools was gradually broadened to provide an extension to a group's capability and to that of an organizational structure and then to geographically separated groups and organizations.

The act of augmenting a number of individuals with the same system permitted a new avenue for interaction: that of computer mediated communication. The study of communication in such a novel situation is the goal of this investigation. The background will include a description of the System as it pertains to human communication. Detailed descriptions of the hardware and the software ("software" refers to any functioning computer program, as opposed to the machinery it runs on) may be obtained in the referenced sources. The origin of the problem will be further explained by the review of literature.

System Description

AHI is designed to take full advantage of the state-of-the-art in computer technology. It is an on-line, real time, time-sharing system with a full duplex (simultaneous transmission and reception) terminal-to-system link. The result is a highly interactive interface between the computer and the user. Indeed, there is little difference between this man-computer interface and a man-to-man interface.

The language medium for this interaction is of two basic kinds: the subset of natural English that has been selected to have specific meaning to the computer program (command language), and natural language text which is meaningful to people. The "command language" for AHI is highly developed with a rigorous syntax that permits maximum flexibilty for the user. It includes many shortcuts that permit a user to communicate with the system about as fast as he can type, manipulate the interface transducers, and think.

When an individual user establishes a connection with the main computer he is able to create, store, organize and manipulate written textual material. Entering written text into computer storage is similar to an automatic typewriter operation. Once text of any kind is entered, it is available for a whole host of operations, including a powerful text editing capability.

The manipulation of symbols is greatly aided by a hierarchical structure. Every user identified unit of text is automatically numbered and assigned a user determined level in the hierarchy. This establishes a relationship to the text in general. The structure facilitates addressing and viewing the text by units of the hierarchy such as statements and branches.

The "Viewsystem" permits the viewing of text in many different ways analogous to "windows" into the stored information. For example, the "viewspecs" facilitate viewing specified levels in the hierarchy thus controlling the amount of detail the user wants displayed or printed.

The tree structure applies to files which are analogous to documents or books and are the storage unit for the executive software. These provide a means of further structuring text. Files can be combined, in part or in whole, with any other file, and the user can "jump" between various files. Part of the AHI capability is similar to a library where a person merely types his request and all books are presented to him for instant composition into a report or other new textual entity. Not only are the files in his own library available to him, but all system users' files are available unless otherwise specified.

The manipulation of textual material through the use of the addressing and viewsystems is a relatively small part of the capabilities offered. There has been some question about the additional power of AHI relative to the numerous operational text editing software systems. A survey by van Dam and Andries answers this question.

> AHI...embodies much more than just a text editor; their aim is to provide a new way of thinking and working by utilizing the power of the computer in all aspects of one's work. (van Dam, 1971, 110)

According to Engelbart (1973), the additional capabilities include: communication among teams with joint and/or simultaneous preparation of text: a "collaborative dialogue"; sending documents, correspondence, and coordinating work: "documentation production and control"; and a library system for the storage and retrieval of relevant literature, etc.: a "research intelligence."

Collaborative dialogue: There are computer aids for the composition of messages and for their subsequent reviewing, cross-referencing, modification, transmission, storage, indexing, and full-text retrieval. A "message" may be one word in length, or a hundred printed pages. In any message there may be formalized citations pointing to specific passages in prior messages, so that a group of related messages becomes a network of recorded-dialogue contributions. There is also: automatic delivery of messages; full cataloging and indexing; on-line accessibility both to message notification and to the full text of all messages; and open-ended storage of the dialogue records. These services enable a community of people who are distributed in space and time to maintain recorded, collaborative dialogue.

Document development, production, and control: There is a rich set of computer aids for the composition, study, and modification of document drafts, and for automatically generating high-quality photocomposition output with flexible controls for font-designation and formatting, to enable the production of publication-grade hardcopy (printing masters, or microform masters). There are processes for collaboration between several writers, and with an editor, in the process of evolving a final draft. There are also aids for the people who must control changes, new-version distributions, etc., and provide the indexing to complex documents or sets of documents.

Research intelligence: The provisions within the Dialogue Support System for cataloging and indexing internally generated items also support the management of externally generated items -- bibliography, contact reports, clippings, notes, etc. With these centrally supplied (therefore uniformly available) services, a community can maintain a dynamic and highly useful "intelligence" data base to help it keep up to date on external happenings that particularly affect it. Computer-generated indexes or on-line retrieval can facilitate access. Citations of external items from within the internally-generated dialogue base -- in the form of annotations, miscellaneous commentary, or supportive references -- offer computer-sensible interlinking of the external information with the internal, and considerably facilitate browsing, retrieval, back-citation searching, etc. (Engelbart, 1973)

The concept is that of a system which permits the manipulation of English language information utilizing the full extent of computer technology. To be augmented is to have a powerful set of tools residing in a state-of-the-art computer system that are used in every aspect of knowledge work, i.e. activity that involves individual and joint preparation of messages, documentation, etc., and sharing the results with communities of knowledge workers. (Engelbart, et al., 1967)

Statement of the Problem

What effect does a computer system designed to augment human intellect have on the individual, groups, and the organization, particularly communication within groups and an organization?

Review of the Literature

This question has not been dealt with to date, primarily because there are no other systems designed to fully augment human intellect. In the case of this system, the effort of the past ten years has been used to develop the system, not to directly consider its effects.

Elsewhere, there has been a great deal of work in natural language English (higher order) applications of computers, including information retrieval systems, question answering or fact retrieval systems (which is an application of artificial intelligence systems), text editing systems, and on-line conference systems. Some consideration of the effects of these kinds of systems as well as the hardware devices they employ has been investigated.

Historically, the limitations of investigations stem from an emphasis on the performance of the computer software and hardware resulting in a neglect of the effect of particular systems on the users. In addition, none of these systems purports to have any great effect, but rather is a tool for a specific calculation or routine. Recently, some broader applications have been considered and some of the effects of computer utilization on people have been investigated.

Information storage and retrieval systems are reviewed first because they represent the least relevant problem area. There are thousands of these systems as indicated by the Annual Review of Information Science and Technology (Montgomery, 1969). Most are basically automated libraries, and are represented by major projects such as Project MAC at MIT which included experiments with the goal of placing an entire community "on-line" with shared information resources (Rees, 1969). One problem plaguing such an undertaking is a lack of computer reliability, as illustrated by the SUPARS at Syracuse University where during a two year period, the system was available to the university population for a total of about one month (Atherton, 1971).

Such computer problems are relatively minor compared to the challenge of representing the information, written by diverse multitudes of authors, such that it may be retrieved by a user unfamiliar with the data base. As J. R. Sharp states,

> There seems to be little point in extending machine facilities which are already available to us whilst we are still comparatively powerless to convert the ideas existing in human brains into language which meets all our needs whether it be used inside or outside a machine (Sharp, 1965).

Efforts to convert ideas into a language which could be used to retrieve the ideas or document surrogates are extensive and represent the major concern in the area of information retrieval. Active in the field is Noah Prywes

(1967) who enumerates the problems under the rubric, "classification methods." The basic problem is one of indexing, which is usually a matter of human judgement. He suggests that the indexers receive intense training and the aid of a computer in the process of content analysis. The question of how much of the task should be done by the computer or by the man is touched upon, and he notes the SMART System developed by Salton, which relies heavily upon the computer. The evaluation of these systems indicates what is of concern, namely the relevance of the citations retrieved (measured in terms of "precision" and "recall").

Homogeneity of the data base aids in providing meaningful relevance, and thus there are relatively large systems in operation such as LITE (a legal system), MEDLARS (medical), CHEM ABSTRACTS, CIRC (a military intelligence system), which bear out this fact. Major companies have been involved with operational systems; however, IBM and others are still concerned with the same issues as those listed by Becker and Hayes in 1963. Sophisticated attempts to deal with the issues concerning the representation of a data base to a specific need are represented by Fairthorne (1967), Borko (1966), and Good (1967) who use approaches ranging from "notification theory" to decision theory with some good analyses of the information flow in between. These efforts are concerned mainly with the effectiveness-efficiency of the system, a limited view as recognized by some investigators.

A more profitable view is taken by Goodman (1968). "User Information Needs..." are his concern to the point where he deals only with the flow of information among personnel. It is difficult to generalize from this kind of study. User needs are something that each organization should assess where it is important to have technical information distributed. The combination of software evaluation and user studies has become the more meaningful way to look at the problem. A great deal of work was done by Alan Rees (1969) to improve evaluation by examining the subjective responses of users of retrieval systems, i.e. relevance. This concept, when added to measures of precision and recall, reflects upon the kernal problem in this use (or any use for that matter) of computers, that of human behavior. Kochen (1964) of IBM emphasized adaptation to use through man-machine interaction, and Paisley and Parker (1965) modelled the process as a receiver controlled communication system. They stated what is perhaps most relevant to this paper from this area. To paraphrase, the important thing is user satisfaction which is a behavioral criterion rather than a structured one, where the behavior response provides the guides to problem solution.

Behavior related research, although recognized as of key importance, has not faired well historically. In 1966, Marks bluntly stated that there is not much, what there is, is of poor quality, and little is known about people in information storage and retrieval systems. This situation has not been reversed. However, knowledge about human behavior has been utilized as a source of ideas and approaches to the problem of indexing, giving rise to a separate area of endeavor called semantic data processing.

Researchers in the area of semantic data processing are primarily concerned with the analysis of language to understand and then apply the mechanisms by which meaning is represented. The goal for application of this work is pointed out by Bobrow (1967). It is to enable the computer to "understand" natural English. This will permit access to a data base using natural English with results eventually comparable to human search and retrieval. Semantic memories such as the one developed by Quillian (1966) model the human memory using sophisticated mathematical and linguistic techniques. Work in this area verges on what is referred to as artificial intelligence, and in essence is the practical application of that field. When data bases can be accessed on the basis of semantic content, the user is not limited to merely retrieving document surrogates as in a library function, but can begin to ask questions of the computer.

Question-answering systems comprise a different area of computer technology. Although it is considered applications oriented, it will be some time before operational services are a reality. (cf. Sass and Wilkinson, 1965) Some systems, such as that developed by Ossorio (1968), have the great promise of actually rendering large bodies of knowledge accessible, but are a long way from daily use. Eventually, as Borden (1967) predicts, we will have a system that will be able to structure, classify, and generate theories, predictions and constructs from a body of truly representative knowledge. In this literature the emphasis is on creating an artificial intelligence to serve whatever ends man sees fit, including understanding himself.

The relevance of the foregoing areas of information storage and retrieval and question-answering systems is primarily historical. Studies of the effect of these systems have been limited to the flow of and utilization of technical information. The arguments and trends in the literature serve as important evidence for a change in emphasis to the human in the system rather than the hardware-software performance.

A major factor influencing the effect of computer systems is the degree to which the software actively processes and transforms information. Fact retrieval systems are more passive than artificial intelligence systems; information storage and retrieval systems are more passive than fact retrieval systems; and text-editing systems are probably the most passive of all. There is no computation or transformation, only direct manipulation of textual information in response to user commands.

Text-editing software is the most similar to intellect augmentation software to be described in the literature. It is designed to be used by an individual in a manner similar to an automatic typewriter or as an aid to programming (e.g. the EMILY system) (van Dam, 1971). Once the typewritten information is entered it can be changed for correcting purposes or rearrangement and composition purposes. The typical text editing software package, such as that available under the GECOS Time Sharing System, (Bair, 1971) enables a user to prepare, edit, and store information that could conceivably be several hundred pages in length. Retrieval from storage for future use, recomposition, or inclusion in another work, is done simply by naming the "file". The only retrieval assistance is a list of the files belonging to one user. Although editors and their companion printout subsystems are in wide use, there are two significant problems. The first is a matter of computer reliabity, usually resultant from the use of the computer for a large number of other programs simultaneously (time-sharing). The second results from the man-computer interface, and the command language.

Computer reliability is a problem that is receiving a great deal of attention from computer technologists in general. While the problems of down-time and errors are gradually being solved, it is important to note the effect on users, especially non-programmers. With text editors and AHI, it is much more likely that the user will be a non-programmer and have had little experience and/or training in computer operation. Increasing problems result in increasing frustration for the user with all the behavioral manifestations to the point at which the user becomes a non-user. This problem is more acute with non-programming personnel who do not understand the causes and do not have alternatives when the system ceases to do the job they need to have done. (Bair, 1971)

Aside from this problem, there is little in the literature dealing with individuals or aggregates of users of text editors. Van Dam's (1971) survey of on-line text editors provides the description necessary for a comparison of text editing and AHI which should be done to clarify the differences. Such a comparison has been done, in response to the skeptics' question, which illustrates that AHI is something other than a fancy text-editor (Bair, 1971). The man-computer communication problem associated with editors is tantamount to the same problem with all on-line interactive computer usage.

The area of man-computer communication embodies a great deal of literature in three major areas: human factors, software design, and user behavior, which respectively emphasize equipment design, programming, and human information processing. The vast quantity of literature dealing with this area per se has been reviewed in the Annual Review of Information Science & Technology by Davis (1966), Mills (1967), et al. through 1970. Mills and Paisley and Parker (1963) are among those researchers who view man and computer communicating as a single system, with the man and the computer as sub-systems. The systems approach has led to modeling and analysis of the process, cf. Grignetti, et al., (1971) and a view of the system as analogous to a human communication dyad (Bair, 1971).

The system model has not received as much attention as the subsystems which correspond to the three areas of investigation mentioned above. There is an extensive but diverse body of research projects and findings in the area of human factors engineering, as Mayer points out (1970). This area is primarily concerned with the design of interface equipment (i.e. terminals) to optimize the user's sensory motor performance. Consequently, this aspect of the communication system depends upon engineering design that is consistent with the findings and the state-of-the-art in hardware (Pew, 1965). Engelbart and his system designers have given a great deal of attention to this aspect of AHI. In fact, some hardware advances were made in building the interface equipment (e.g. the mouse and the binary keyset) (Engelbart, 1967).

Software design is becoming more a problem of man-computer communication than increasing the computer's capability to provide problem calculations, such as a space trajectory. Licklider (1968b) has long argued for efforts to achieve a man-machine "symbiosis" dependent upon a program that is compatible with human functioning. Carbonell (1969) represents those who have used a mathematical modeling approach to deal with basic issues such as task allocation between man and computer. Other issues are a matter of concern to the more user oriented researchers. For example, the essential difference between man and computer is the computer's requirement for precision and perfection as opposed to man's error proneness and capability to deal with abstractions and ambiguities. This difference can be dealt with through software design.

Consideration of the differences between man and computer have led to a focus on the user as a component of the system. Uttal (1967) is among those writers that consider the behavior or psychology of the user in addition to human factors and computer characteristics. An examination of man in this context requires that one must draw upon the vast literature in psychology, especially experimental, which largely treats him as an information processor.

Psychologists such as Pew, Melton, Fitts, Hunt, Posner, and Biederman, for example, have done conceptual and laboratory work that can be drawn upon to delineate the human information processing that occurs in a man-computer system. A taxonomy of human functional tasks has been developed from this work that permits quantitative statements about the human's performance in the system and also provides a framework from which predictions involving processing time and efficiency can be made. This, of course, can be valuable to designers who are trying to optimize man-computer communication (Bair, 1971).

The area of man-computer communication does not at present deal with the effects on groups of users, nor is there any investigation of the effects of intellect augmentation software (cf. Computer Augmentation of Human Reasoning, where Sass and Wilkinson (1965) cite a number of efforts in this area, such as heuristics, libraries, and question-answering systems, but do not touch upon the effects of a system such as AHI). As has been pointed out, text editors are similar to AHI, great in numbers, but apparently not very interesting in terms of effects. The psychological effects of computers in general on man are being studied, and the continuing work in the laboratory will shed more light on human information processing. However, reviewing this literature does not tell us anything about the impact of the unique technology that AHI offers, especially on the communication among users.

Recently there have been very interesting efforts in another area, that of "on-line conferencing." In its simplest form, this is the use of an on-line computer in a manner analogous to a telephone for handling messages between remotely located conferees. In its more complex implementation, it is represented by the DELPHI system, which is a specific kind of conferencing. According to Turoff (1971), DELPHI is the use of anonymous responses to questionnaires and other statements of problems, where these responses are then compiled and fed back to the respondants, who then respond to this feedback, and so on. He recommends the automation of the process and forecasts a "collective intelligence" from such uses of computers (Turoff, 1971, 321).

Hall (1971) describes the details of DELPHI automated conferencing, which he terms "a specific type of decision making system". The computer serves as a data collection and routing device which enables a geographically scattered group of experts on some subject to conduct remotely those discussions and referendums that might occur at a conventional face-to-face conference. The mechanics of the conference are handled by the computer.

On-line conferencing is one of the capabilities of the AHI system, and the system could easily be adapted for DELPHI. Thus, the literature in this area is highly relevant. Consideration of automated conferencing usually entails the implications of using computers to mediate interpersonal communication in general. Turoff goes even further by discussing the implications for organizational structures. His philosophical approach is a beginning at describing the conditions existing in organizations that would be affected by AHI technology.

The purpose of DELPHI is to establish a meaningful group communication structure, according to Turoff (1971, 317). He presents the criteria for meaningfulness and then appropriate applications of DELPHI. One of the criteria for meaningfulness arises out of the effect of computerized conferencing, which is:

> ...the group pressure to restrict discussion to the meat of the issue. Verbose statements always tend to receive low acceptance votes and individuals quickly learn, because of this, to sharpen their position if they wish to make a point (Turoff, 1971, 321)

The problems inherent in large organizational structures are reviewed, such as the need for hierarchical structure, the increasingly complex environment, the effects of size, and the resultant lack of effective communication and problem solving capability. He notes the inadequacies of formal communication channels.

> The result is a growing lack in many organizations of effective communications about various problems. The individual perceiving the situation faces a choice of either establishing informal communication channels and perhaps suffering the consequences for bypassing the established modes or suffering in silence and adapting a game playing attitude toward the communication process available to him. When this latter attitude is characteristic of a large segment of the organization, there is no longer an effective human communication process and individuals become extremely unresponsive to attempts to effectively deal with problems (Turoff, 1971, 323).

Although the use of the computer might be expected to be a potential solution to this very common downfall in organizations, Turoff surprisingly interjects a possible failure for this to occur.

> Psychologists would agree that given the alternative of an unresponsive human communication process or a responsive man-machine communication process most individuals will shift their efforts at communication to the machine (Turoff, 1971, 323).

This is the real danger with the AHI system: that it might act as a surrogate for effective communication or give the illusion that effective communication exists. This effect is fundamental and will be closely observed in this study. Certainly, the AHI system will affect the communication process.

A session of the International Conference on Computer Communication in the Fall of 1972, was devoted to on-line conferencing or "tele-conferencing". The session chairman, Conrath, clearly established the extent of the work which was represented by the papers presented at this conference. He outlined the issues and posed questions which are summarized by the question, "Why hasn't more been done on man-computer-man communication and the augmenting of interpersonal communication?" He indicated concern that "...he could not find a wider variety of research..." than that represented in his session on "assisting man-to-man interfaces and related issues (Conrath, 1972b, 146)."

Although the literature does not deal with the important questions of effect, as Conrath points out, his own work does. He provides a conceptual framework, definitions, and a methodology for investigating the computer's impact on organizational structure (Conrath, 1972a). This is unlike other reported work in that it deals with the process that is an organization rather than the resultant organizational schemes, such as what departments and management positions should be created to manage computer installations. He describes an organization based on an excellent (and obvious) definition. An organization is a set of interpersonal networks, each of which is based on interpersonal relations comprised of the communications among the members of that organization (Conrath, 1972a, 68). The elaboration that follows represents a great insight into the workings of organizations, which is supported by an empirical study.

Conrath employs a field study methodology using a modification of the Quickborner "communications tally sheet." The overall goal was to obtain data about the properties of an organization based on specific communication events with minimal disruption (Conrath, 1972a, 71). This would then provide a context for the measurement of impact on organizational structure, i.e. change. This methodology for measuring the organizational impact of the computer may be appropriate for the study proposed here, and will be discussed in detail in the section on methodology. It is interesting that Conrath does not mention AHI per se, but rather in general.

> The important impact of the computer lies in the development of software that will allow it to assist and augment interpersonal interactions (Conrath, 1972a, 72).

Thus, Conrath assigns substantial importance to the AHI System technology. How the system purports to augment interpersonal interactions and what in fact it actually does will be described by this investigation.

Hypotheses

The literature indicates that there will be effects on the individual, the communication among individuals, and the organization. Consequently, there are three major hypotheses that are concerned with effects on the population in three areas: (1) the individual, (2) the communication in groups and teams, and (3) the organization. The hypotheses represent the effects that are ultimately expected as the population becomes an "Augmented Knowledge Workshop" which is described below.

1. The individual's verbal thought processes will be aided by the rapid availability of his own information, the ease of changing that information both in its content and structure, and the flexible control of structure viewing (cf. Engelbart, 1973).

The rigidity of written information has a relatively unexplored effect on the development of a person's ideas, thoughts, etc. He traditionally is limited to handwriting or typing to make thoughts initially visible, and then to rewriting each time clarification, correction, up-dating, restructuring, etc., is necessary. This may require the intervention of a typist and communication of the necessary changes to this second party. The longer the paper, or whatever, the greater the problem of revision. Once a lengthy paper is prepared, the thinker's ability to massage, manipulate and creatively deal with those ideas is curtailed.

When thoughts, etc., are entered into the AHI system, it is predicted that they will not lose the flexibilty inherent in the thought process, but conceivably will gain additional flexibility resulting from the visibility of written information. The capability of AHI to permit rapid changes in stored text of any kind was described in the Introduction. From this it can be expected that an individual will move through his stored ideas with great ease -- massaging, and creatively engaging words, concepts, facts, patterns, and the various nuances of recorded thought. He also has, at any time, a copy to share with whomever he chooses.

In addition to the flexibility gained, the hierarchical structure adds what may be a new dimension to computer stored thought. The structure permits verbal units to be placed at a level indicating relative importance, source, category, etc. Thus, it is predicted that relationships can be captured or established which otherwise might be obscured by semantic limitations.

2. The communication of individuals accomplishing their work on the system will be facilitated by the free access permitted to all individuals' work as structured into the system, by the ease of making changes in the written work of groups, by the capability to transmit messages or other information through the computer, and by the

capability to simultaneously access and modify stored information by numbers of persons.

Knowledge may be collected and compiled thus taking maximum advantage of the resources of the on-line working group resulting in better decisions and actions.

The result would be an "Augmented Knowledge Workshop" promoting the integration and synthesis of the efforts of individuals to yield a new level of group creativity. Consensus would be represented by a stored record created simultaneously over time. The leaders of the Augmentation Research Center (ARC), Mssrs. Engelbart, Norton, and Watson, elaborate on the concept of the "knowledge workshop" as follows.

> The term "knowledge workshop" is built directly upon the terms "knowledge work" and "knowledge worker", whose special use is from Peter Drucker (1969). He develops a much larger theme about these concepts, adding terms such as "knowledge technologies", "knowledge economy", and "knowledge society", and pointing out that the growing level and importance of knowledge-work activity in our society will produce a discontinuity in our cultural evolution of a scale commensurate with that of the industrial revolution.
>
> The knowledge workshop is the specially provided environment in which knowledge workers do their knowledge work. We can talk about a small knowledge workshop for an individual, or a large knowledge workshop for an organization. Knowledge workshops have existed for centuries, but here we consider maximizing their effectiveness by systematically evolving tools, methods, etc., with heavy dependence upon the new technologies of computer time sharing and networking. The result is the "Augmented Knowledge Worker" (AKW) which describes an individual effectively using AHI.

> Basic workshop functions will serve the daily handling of the AKW's working information -- of their notes, things-to-do lists, memos, letters, designs, plans, budgets, announcements, commentary, proposals, reports, programs, documentation, item-control catalogs, etc. And before it can sensibly be of much value, as Engelbart has stated, the Augmentation System has to provide for the grubby cut-and-try detail involved in the minute-by-minute, day-after-day worker's handling of this information: in the user's composition, studying, commenting upon, arguing about, modifying, communicating, publishing, presenting, etc. (Engelbart, Norton, Watson, 1973)

3. The ease of handling Knowledge Worker tasks and the openness among AKWs will have a strong impact on an organization where groups and teams are augmented, by facilitating the vertical communication in that organization and ultimately, the organization itself.

When the AKWs are at all levels in an organization, management and subordinates can communicate through the system with the same ease that co-workers can interact. The message transmission capability would facilitate the conduct of most of the organization's business through AHI.

The tradeoff from these increases in communication has historically been a loss of efficiency (cf. March, 1965). However, a very important product of AHI is predicted to be the implementation of modern, "open" management techniques without loss of efficiency.

These hypotheses are interrelated and interdependent. The methods to be used will not deal with each hypothesis singly, but data will be provided that can be interpreted in light of each hypothesis to support or reject it.

Section II
METHODS AND PROCEDURES

In order to obtain meaningful data illuminating the effects of the Augmented Human Intellect System, every reasonable technique has been employed to document, as thoroughly as possible, the process of evolution to the integrated use of the technology on a daily basis, particularly for communication. This study reports a milestone in that evolution after seven months of System use on an experimental basis.

Background

The following methodological assumptions are made for this study.

(1) If the System has an effect (positive or negative) then that effect will result in a corresponding measurable change in the attitudes of System users toward the System and general technology that it represents.

(2) Measuring the attitude of the population involved is one valid way of ascertaining the effects. Attitude change results primarily from effectiveness, and conversely, attitude strongly influences effectiveness. It is also a desirable method due to the indirectness by which data is obtained. However, a priori attitude will affect the propensity to use the System. This use is necessary to cause any attitude change, while positive System effects will also be demonstrated by increased or continued System usage. (Attitude change due to maturation will be noted by comparison to a control group.)

(3) It follows that attitudes will vary directly with changes in communication among the subjects. Thus, improved communication, horizontally or vertically, would result in more positive attitudes.

(4) Respondant reports are a valid means of acertaining changes in performance/effectiveness. Although subjective, a user's judgements about the utility of a tool to him are reliable data when there is a significant number of users.

Based on these assumptions, the investigation is a descriptive, field study. Questionnaires and direct observation are the primary sources of data. There are six specific types of instruments, (1) a chronicle of comments and unstructured participant observation, (2) case study descriptions, (3) interviews, (4) a controlled attitude questionnaire, (5) a content questionnaire and (6) a tally of comunication transactions. Influential variables, population demographic factors and job task type, and proficiency of use relative to the total number of hours of use, are reported.

Population Characteristics

The population for this study is pre-determined by the organizational structure where the System is being implemented. Two similiar organizational units are employed as the experimental group and the control group respectively.

The organization is a government research and development laboratory dealing primarily with electronics. The population is within a structure specializing in information science which develops, tests, and evaluates certain kinds of computer software. Almost all personnel are college educated, and a sizable percentage have advanced degrees (see Appendix A).

The kind of work done by the population could have important bearing on the interpretation of the results. Thus, the investigator established a framework which was used to categorize what kinds of work involved what percentage of the person's time.

The list of "job task types" was created by the investigator intuitively from observations and discussions with members of the population. A pilot study of a cross section of the population resulted in modification and validation of the final list, which was found to be representative. A semi-structured interview was then given. The subjects were asked to determine the percent of time spent in each job task type. This is an indicator of any differences between sub-groups or the test group and the control group which could act as spurious variables.

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(4) Respondant reports are a valid means of acertaining changes in performance/effectiveness. Although subjective, a user's judgements about the utility of a tool to him are reliable data when there is a significant number of users.

Subjects were assigned to sub-groups within the organizational unit based on age, length of service time, rank, job task type profile, and type of position (manager, engineer, administrator, clerical, and experience with computers).

Job Task Types (general catagories of job activities that are accomplished by the population):

1. Programming
2. Project engineering, including: contract paperwork (forms memos, etc.), reviewing proposals and reports
3. Writing plans and/or reports
4. Software operation (including evaluation, debugging of software packages)
5. Briefings
6. Demonstrations of systems
7. Managing other personnel
8. Administrative paperwork
9. Study, review of the state-of-the-art, reading, literature search, etc.
10. Secretarial work.

(See Appendix A for subject job task type and demographic data.)

Observations of Effect on Behavior

The most straightforward means to understand the process and effects this study is concerned with is to directly observe the behaviors of the population during the period of exposure to System usage. It is particularly true in this instance because there are numerous problems and events that cannot be anticipated -- this is the first System implementation for non-developmental purposes.

Therefore, closed ended instruments, such as questionnaires, cannot be relied upon to capture all behavioral changes.

It is important to document the specific uses of the System which are an important indicator of effectiveness -- if the the System is selected as an alternative to conventional means, this clearly demonstrates that there is some reward. This was recorded in the Chronicle (see below) with any other user-entered experiences.

However, the presence of reward does not necessarily support the hypotheses; other factors such as novelty and group pressure could cause the same results. Thus, the question must be asked of the users: why, in fact, was the System selected in particlar situations and what experience resulted. Interviews (see below) are used here. Again, this information does illuminate important motivational factors, but it is limited to conscious reactions, subject to influence by the situational set.

System uses and the interview data may be corroborated by noting the actual accompanying behavior. The resultant case history provides insight on the basis of actions, a most important datum that is possible (and necessary) to collect when the the population is relatively small. Direct, serendipitous observation is possible because the observer is co-located with the population and has the opportunity to interact with them on a daily basis (see below).

The Chronicle

The Chronicle was established as a vehicle for recording the serendipitous experiences by members of the population through the System. Any experience that was perceived as noteworthy by a subject was recorded in a special file named CHRON in his directory or in that of the investigator. The investigator then perused the files of the population and compiled a summary, collating and synthesizing similar events. The voluntary selection of events was not expected to yield more than a record. This factor is important for realistic interpretation of the data which are not representative.

Personal Account

The investigator has been a user of the System for over a year and has been using the display System for about seven months, since its initial availability outside the Stanford Research Institute. This, as well as other papers, has been prepared on the System. Thus, my experiences are included wherever appropriate, particularly in documenting the uses of the System both for communication and for effect on the individual's thought processes, but not for motivational -- attitudinal data.

Interviews

Interviews were conducted at intervals throughout the period that began with System availability to the population of 20 persons. Two non-members of the organization were employed to conduct unstructured interviews that allowed the maximum opportunity for open ended responses. Hopefully this enabled the respondent to introduce those things which were most important to him, while minimizing the structuring of these perceptions by the interviewer. General questions such as, "Could you tell me more about that?" were followed by more specific questions only when deemed necessary by the interviewer to gain some more detailed information from reluctant respondents. The interviews were non-directive to the point of resembling a discussion. Although the style was intended to be Rogerian, suggestions were used when certain problems were anticipated, eg. "Did you have trouble with output directives?" (see Appendix H)

Direct Observation

The investigator's position was a vantage point from which to gather empirical data. Events were recorded as they drew the attention of the investigator. Oportunities for this kind of observation included conversations that were overheard ("eavesdropping"), random participation in conversations, sessions arising out of a request for assistance on the System, observing the process of document preparation and the end product of System use, and reviews of the contents of subjects' files.

This kind of record is highly impressionistic and is dependent more than the other techniques upon the observer's perceptual set. In this case it was mitigated by the working environment in which subjects were non-volunteers involved primarily because of their location in the organization. There were no direct rewards for participation and no lessening of the workload imposed by management. A minimum of additional obtrusion into the working world of the subjects was imperative, thus supporting the use of techniques such as this one.

The combination of these methods was intended to be synergistic -- each is subject to relatively strong subjective bias. However, the combination is capable of providing a valuable description of the effects and impact of the System on the ways in which the subjects behaved while accomplishing knowledge work.

Controlled Attitude Change Measurement

The "T" Questionnaire (see Appendix C) was employed to measure possible effects on the attitudes of the population. The assumption was that changes in attitude toward the System technology and the working environment, observed in a controlled format, would permit conclusions to be drawn about the effectiveness of the System.

This is a standardized attitude questionnaire which was designed to measure the subject's general attitude toward the AHI concept/technology, pretesting before contacting the System and then after training and usage. A four position scale provided a forced choice decision. The positions were labelled "strongly agree", "agree", "disagree", "strongly disagree".

The "T" questionnaire was given to one group of users before use and one group of non-users as a control. This constituted a pretest, and provided the basis for comparison with the results of the same questionnaire after full usage of System. The split group pretest is a control for test effects.

There were numerous factors that could influence attitudes other than the independent variable, primarily due to the small population size. These were identified and all the information available concerning each was recorded. This was then included as part of the data base for analysis. In this manner, correlatiions were more reliable. The potentially spurious variables were grouped under the following headings:

(1) Population characteristics

The description of the population included Job Task Type, and demographic characteristics, including age, length of government service, position (title if a manager, otherwise scientific specialty), and rank (see the section on population).

(2) Training

Training was as nearly the same for each subject as possible although much of the learning occurred through System use. Learning time was recorded from periodic interviews, questionnaires, and/or System maintained usage records. Whenever possible, the records were maintained from the first training or experience with the System.

(3) Proficiency

Proficiency in the use of the teletypewriter version of the System was measured near the end of the experimental period. The test consisted of a paragraph of text that contained numerous errors, and a corrected version with the errors marked. The subject was asked to copy the incorrect version into his computer space, edit the errors as indicated on the correct version, and then send the corrected copy to the experimenter. Subjects were also requested to use the other communication modes to notify the experimenter that he had completed the test. (See the Exercise in Appendix G).

(4) Terminal availability and type

The type of terminal used and the availablity of the terminal and System, was noted on a percentage basis. Of particular concern was the difference resultant from the use of the CRT (TV-like terminal) and the tele-typewriter terminals. Connect time to the System was recorded automatically.

(5) Organizational Climate

The Organizational Climate Index (OCI) (Stern, 1969, and Richman, 1970) was employed to measure the differences, if any, between the control and experimental groups and subgroups based on the demographic data.

The OCI, as the title indicates, is designed to measure the climate that exists within an organization as perceived by the members of that organization. These perceptions ultimately affect how a person feels about the place where he works. This is a result of, at least for a large number of persons measured together, the climate. The questionnaire was designed to be as indirect as possible, thus relieving the individual of the more subjective burden of judging his job environment. Instead, the test includes 300 statements about the kinds of things that can go on in the organization which are rated true or false.

A thorough statistical analysis by the Syracuse University Psychogical Research Center's computer program loaded the statements on 38 factors (see Richman and Stern, 1969) which are descriptive of organizational climates in general, and have been tested at other institutions for validity and reliability.

Thus, this test provided an excellent clinical experimental control as well as a pretest for future investigations (a year or so hence) which might compare the results of a posttest to determine if there is any effect on the organizational climate by the AHI System.

Structured Observations and Communication Analysis

Content Questionnaire ("Q")

"Q" was administered only at the end of the experimental use period to determine the specific reactions to use of AHI by those who had reached a functional proficiency. This included questions on the type of terminal, System availability, effect on workload, disappointments encountered and particular uses (see Appendix E). Two types of questions were used:

1. Five position Likert type scale questions which dealt with the effect of AHI on specific daily behavior routines, especially communication.

2. Multiple choice and open ended questions were employed to gather information about the percentage of time the System was used, problems not addressed in the chronicle, etc., to establish any possible cause of spurious effects.

Communication Tally Analysis

Conrath's communication tally method was applied to the entire population and an additional level of management as well. As suggested in the review of literature, this is the best method found for obtaining data that can give an indication of the changes in communication patterns due to the use of the System. Communication events were recorded for a period of approximately one week.

However, difficulties that cannot be solved a priori were anticipated. Conrath (1972) noted the potential loss of reliability due to the surfacing of inhibitions toward participation. Using only volunteers assures some cooperation in filling out the extensive tally sheet, but there still may be a problem when the subject finds himself with a sizable burden in addition to an already heavy workload.

The population size for this technique limits generalization. But some prediction, including the establishment of the communication network (patterns), was possible, especially since subjects were from higher level management as well as from the bottom level. Any change (i.e. use of the System to communicate) will increase the probability that AHI will cause these changes in other persons as well. This technique will have to be exploratory, but should be interesting at the very least.

Another problem was the representativeness of the time period that was used. A five day period was selected with the full realization that this was a short time and might not be representative. However, it has been ascertained from experience that this is the maximum time that such a population can be expected to cooperate with the additional load. (Conrath, personal communication, 1973). The short time period notwithstanding, the data should be sufficient to draw some conclusions.

The technique involves recording interactions in a binary fashion; either an interaction has taken place or it has not. The interactions are defined as essential interpersonal communications, on an iniated/received whom basis, by mode, elapsed time category and number of persons involved. "Essential interpersonal communications include all interpersonal interactions except for personal greetings, when restricted to no more than that, and requests for favours, such as 'do you have the time?,' that were dependent solely upon physical proximity." (Conrath, 1972b, 11) All events are recorded by an "R" for received, and an "I" for initiated. The tally sheet (see Appendix I) is a complete representation of the information that is recorded.

This tally sheet has four additional categories for the use of the System: link, send message, shared files, and

Journal subsystem. In this way the quantitative changes in the mode of communication are noted.

Data on the authority structure, physical location (office landscape), and other factors were descriptively recorded in the section on population. Of importance were changes in the vertical channels of communication within the organization where the managers are augmented and thus will have the computer based modes of interaction available. The traditional difficulty of communicating with managers may be overcome, but circumvention of formal authority channels might become a problem. The instructions (see Appendix I) were modified for use with this particular population. Data analysis was done by computer tabulation of the coded data.

Design Format Showing All Questionnaires

GROUPS	PRETEST	TREATMENT	POSTTEST
USER 1	(I) T, OCI	X	(II) T, Q
USER 2	OCI	X	(III) T, Q
CONTROL 1	(IV) T, OCI		(V) T
CONTROL 2	OCI		(VI) T

The design format shows the split half "T" Questionnaire pretest where half the user group and half the control group did not receive the pretest. These groups were assigned Roman numerals for the purpose of computer data processing. The OCI was given to all subjects at the time of the pretest to control for group differences, etc. The "Q" Questionnaire was given only to the users to gather specific reactions to System use.

This is a non-randomized Solomon four-group design with a small N. The N of approximately 36 (4 groups of 9 each) necessitated the non-random selection of subjects for the sub-groups. (See the discussion of the population.)

The above design is constructed to control for test effects of the "T" questionnaire and time lapse changes during the experimental period (population maturation). We cannot change the group membership due to the fixed organizational structure. The demographic profile provides a check on subject differences that might affect the outcome (Appendix A).

The difference between the pretest and posttest is the key measure of differences due to the treatment. However, the nature of the "T" questionnaire may cause test effects after the pretest thus confounding the posttest. Differences between the posttest for subgroups (1) and (2) can be attributed to pretest "T" effect since the sub-groups (i.e. the sub-division of the user and non-user groups) are matched on all other known variables. The key test effect is predicted to be an increased awareness of the technology.

This investigation has been designed to gather information about the effect of the AHI System during the process of implementation employing as many different techniques as is feasible in a real world, working environment. The purpose of this "shotgun" approach is to compensate for the limitations of psychometric techniques applied in a non-laboratory environment. The effects that are being investigated are so novel (never having been examined before) that a detailed account of the process of implementing an Augmented Human Intellect System would probably be a significant contribution in itself.

The following sections are divided on the basis of the data collection technique. It is hoped that each section is just a beginning of the analysis of the effects of what Peter Drucker (1967) calls the "knowledge revolution" (analogous to the industrial revolution) for which AHI is the prototype tool.

Section III
OBSERVED BEHAVIORS

Learning to be an Augmented Knowledge Worker

The resistance to learning a new System as a way of doing one's daily knowledge work was higher than expected. Traditional work patterns were adhered to with a great deal of persistence by the population, a manifestation of the "rejection phenomenon." This occurs frequently upon the introduction of new technology; however, it was surprising in this context. It demonstrates that education and an understanding of the technology in general are not prerequisites for immediate acceptance. In addition, in this case the methods of communicating and accomplishing daily work are habitual and consequently some extinction had to occur before new habits could be learned.

Excuses for not using the System were exemplified by comments such as, "there isn't a terminal around," "I can't remember how to do it," "there isn't a good manual that I can understand," "I have too much work to do," etc. It seems worthwhile to discuss some of these, how we dealt with them, and offer some speculation about the reasons behind this behavior. (The problem here, of course, is that the reasons are largely a function of individual personalities. With our population size, any generalization must be done with this factor in mind.)

There are twelve portable typewriter terminals and 3 IMLAC displays for 20 subjects. The jobs for approximately 70% of these individuals require a great deal of written work. An important exception is programming for another System. This is a major task for at least one third of the population and has not been done on AHI. At SRI; however, all programming has been done on the System since its inception. This will be discussed further under the heading, "Population Characteristics."

Terminal availability is a crucial variable affecting the learning process. There is strong resistance to leaving one's work space to work in another or to physically carry a terminal to that area from some other work space. Ideally, every user would have his own terminal. This is not warranted by current usage levels here, nor is it feasible financially. However, it has become a problem to the point where it caused some people not to use the System. (Management and the observer tried to overcome this by carrying terminals to people who have use for them but resist getting their own.)

The System use manual cannot serve as a training manual. It is over 200 pages in length and is not organized in a self apparent way. It does not serve the beginner well as a reference because its use requires an understanding of the System. The syntax for the command language is complex (although functional and very effective for those who have learned to use the System) and requires that detailed explanation be available for reference. The command language summary provided at training time was too cryptic to serve this purpose.

An introductory, self-explanatory training manual was not available. Perhaps the complexity and richness of AHI rendered it a formidable task. The stopgap measure was to have capable users stand by in the immediate vicinity to aid the struggling neophyte at a moments notice while an introductory command summary was written.

Learning to use AHI was assigned a low priority when the subject was under pressure to get other jobs done. Of course, this could be an excuse that might in fact not be the actual cause. Admittedly, it is a real nuisance to change the tools for doing one's job and learn a new skill in the middle of things.

However, after a trial period of approximately one month, it was concluded in light of these problems that a policy regarding use should be established by management. The decision to require use was made in light of the hypothesis that any work that can be hand written can be done on the System with the exception of that requiring special alphanumerics. This was based on the following assumptions.

(1) If the System is only used occasionally, i.e. a couple of times a week, then the level of proficiency necessary to make the System truly an improvement will never be attained. Practice through regular use is necessary.

(2) If new users are instructed to use the System for all possible knowledge work, then we can determine what work is not appropriate for AHI by observation.

(3) The System offers alternatives to habitual ways of communicating in written form. New users will naturally be reluctant to use the System unless strongly encouraged.

The requirement was enforced by instructing the secretaries of the population not to accept any handwritten drafts for typing unless an exception was specifically authorized by their supervisor. Work that necessitated the supervisor's review and coordination would only be reviewed through AHI (drafts are printed out for transmission elsewhere). It was expected that there would be an initial drop in work output until some level of proficiency was reached, estimated to be about one month. A little friendly persuasion seemed appropriate to overcome initial problems -- "Try it, you'll like it".

The requirement met with definite negative reactions of an emotional nature even though all persons involved were given at least a month, and in some cases up to four months, to voluntarily use AHI for whatever they wished. They were encouraged to use it for a status report to their immediate manager, himself a user. A secretary was employed to enter into the System any written work that had already been completed, which then would be available for updating, etc. This also met with resistance.

Individuals manifested a range of behaviors, from trying to ignore the whole thing to actively campaigning against it. Some of those who tried became distressed when System problems were encountered. Indeed, initial System performance did leave a lot to be desired in dependability, but it was not much different from any experimental computer facility. The reactions seemed to correlate with the observer's assessment of personality type. Those who seemed to be closed minded were the most threatened by required use (this was examined more objectively through the use of test instruments -- see Section IV). Also, those manifesting a high ego involvement with their work reacted more negatively than did others.

Factors other than personality and demographic attributes were relatively consistent. Equipment and training had been available for about four months. Everyone had been exposed to the System, either through classes or by being in the area where the System is being used. Age of the potential user did not seem to be a factor affecting motivation to begin the task of learning; neither did experience with computers, or job task type. The variable was one that is most obvious and generally true of any new tool-- aggressiveness (generic use). The least aggressive subjects initially ignored the System. As the more inhibited persons saw their colleagues becoming involved with AHI, they responded to the pressure to become real AKWs.

Ego threat was identified on the basis of verbal and non-verbal behaviors over a period of several months. When questioned about their work, a subject's defensiveness was noted by facial flushing, elusive or aggressive statements, or reverse attack where the subject would say, "if I had nothing else to do like you, I'd learn it...." Complaining within earshot of the observer usually centered around how busy and how important it was that he not be imposed upon. These are examples of very impressionistic observations; however, they do offer some insight.

Interviews with two subjects who were System programmers revealed that they were not able, in their judgment, to use the System for a long report. The joint effort was to be published, and the primary reason for not using AHI was a lack of time to gain the proficiency necessary.

More specific reasons were given that reflect upon the difficulty of gaining that proficiency and the limitations of the teletype oriented TNLS (as opposed to the display version of AHI, DNLS, which is discussed in Section V). The information was not visible enough for maintenance of the train of thought. Some subjects felt that they could not see previous pages or the context of the current location of the pointer (the position in the text where any editing commands will take effect) easily enough. (It requires that enough text be printed for the user to identify it in relation to the document). Addressing was not "natural" enough. Inadequate training was probably a significant factor here. The installation of a printer for quality hardcopy output encouraged use and improved the situation considerably by providing some visability after the fact.

It would be misleading to discuss the problems experienced by the trainees without mentioning the trainers. Teaching the use of such a complex system is difficult under any circumstances, and in this case it was the first attempt by those individuals who were responsible. They had some help from the staff at SRI(ARC) but this was limited for a number of good reasons. Thus, they were on their own learning about learning and the System at the same time. There does not seem to be much point in trying to assess the influence of teaching personnel and method, but it can be concluded that experienced and more skilled teachers would have lessened some of the problems encountered.

Briefly, initial instruction was done in small groups. Each person was given a terminal so that he could do the operation as it was described by the instructor. The log-in operation, entering the appropriate subsystem, status listings, error messages, etc., were covered in the order they would normally be used. After that, operations were described in the order of usefulness, a function of usage frequency. After two or three days of this the trainees were told to practice, while the instructors stoo`by to give assistance. In the future, a conceptual overview of the System would probably help prior to any attempted usage.

The difference between on-line composition and use as an automatic typewriter became an important factor as new users progressed. This differentiation was remarkably discrete as evidenced by the work methods employed.

On-line composition was the modus operandi with the first few persons to learn (who had been "on" the System for over a year). It is characterized by little use of paper, either for the original composition of new ideas or for the proofreading of drafted papers. Instead, all structuring, outlining, wording and phrasing, etc., is done while on-line.

Use as an automatic typewriter is characterized by handwriting outlines and original drafts often creating a complete draft that is typed into the System by a secretary. A printout is then used for proofreading and revising which are done on the printout itself. These are then entered into the System on-line. Further reviewing is done in a similar manner. There is no effort to enter ideas directly using an on-line terminal. There may be numerous reasons for this, not the least of which is the non-availability of a CRT display or inability to use the display version of AHI. As mentioned above, typing skill is another limiting factor, although those who have used the System for on-line composition have found that a typing ability evolves naturally.

The psychology of the situation also played an important role. Certain subjects expressed a reluctance to use a teletype because typing was beneath them. Comments such as, "what will the secretaries do," or "I wasn't hired as a typist," etc., were noted. The reasons are not clear; however, why transition from automatic typewriter use to intellect augmentation appears to be an important threshold in the process of becoming an AKW.

Continuing usage on a day to day basis begins to make the System transparent, which is probably necessary for the transition to on-line composition and intellect augmentation in general. The command language, addressing, viewing, operating the terminal, and the other mechanisms necessary for usage become of less concern, freeing the individual to deal directly with the subject matter at hand. None of the population has experienced total System transparency, but a few have come close. They are limited somewhat by technical difficulties such as computer crashes.

Observations of true AKWs at SRI are evidence that a transparency can be achieved, at least for a large percentage of the kinds of work done. Those observed had been on the System for a number of years leading us to believe that full capability may take years. This is, of course, a function of what the user selects to do on-line -- little used facilities, such as other ARPA network resources residing on other computers, would be less transparent.

Transparency is also characteristic of the rules of the spontaneous use of language, as in conversational speech. The experience and process of learning to use AHI is analogous to the acquisition of natural language and reminds one of the work of the noted psychologist, Jean Piaget. There is a definite syntax applied to the vocabulary that enables the person to combine command words to perform novel operations, thus generating new and acceptable patterns of language. These in turn facilitate different procedures and sequences of operations by the programs. It is quite obvious at the outset that there are many different ways to do the same thing. This permits a personal "style" to evolve for each individual that is supposedly most effective for him (see Section V, Proficiency Test).

As with natural language, a subliminal knowledge of the basic rules is used to generate new command "sentences" from the given vocabulary that the computer will recognize. The subliminal attribute is closely related to the transparency discussed above. We can speculate that a person's ability to generalize from the command listings will be a decisive factor in his successful utilization of the System, especially as a tool for creative efforts. Once he becomes adept at "speaking the System's language", different reactions are observable while dependency upon the System increases.

Effects on the Individual

A pressure on the user to work at a high capacity while on-line was one of the most prominent experiences observed. A great deal of involvement occurs, especially when the user is on a display terminal.

One causal factor may be the automatic logout if nothing is done for about fifteen minutes, resulting in some anxiety whenever one is distracted. This is not sufficient cause for things such as an extraordinary reluctance to engage any person who wishes to interrupt an AKW. Another possiblility is limited System availability due to "down time" and hardware "bugs". An available System, functioning reliably and rapidly is a strong incentive to "use it while you can". These factors are influential, but the reasons appear to be more profound.

The act of creating something that will be highly dynamic, not permanent or rigid, is very attractive, albeit subliminally. A person experiences a freedom and release from the responsibility of having to live with some document that is set in ink. It is analogous to thinking through ideas and structuring a draft mentally. It can be altered in almost any way at any time, thus facilitating creative experimentation.

Not only is there an increase in the freedom to be creative with content, but there tends to be an uninhibited work rate, limited only by the present hardware devices. If a writer is aware that he will have to alter or retype his paper if he makes an error or forgets an idea, the rate at which he proceeds must necessarily be restrained. This is true even when a draft is handwritten. There is a limit to the amount of revision that can be done between the lines, if legibility does not suffer, then one simply runs out of paper. There have been numerous instances of revision where there would not have been without the System.

A new user may have to learn to be less inhibited about rendering his ideas visible at an earlier stage of development than would be the case ordinarily. Perhaps more important is that he feels free to change and remould whatever he "dumped" into the System. There has traditionally been a lot of negative reinforcement associated with changing written matter, even if it is only a personal working document, which AHI minimizes.

AHI appears to provide unprecedented flexibility and freedom with textual information for the individual. This is dependent upon the joint use of the display (DNLS) and the teletype versions of the on-line System. In this discussion, observations include both types of terminals.

The alternate use of the two terminals is desirable particularly during the on-line composition of a lengthy report. Briefly, the teletype is best for typing in sequences of text -- a hardcopy is produced, and it is easy to keep track of the current position relative to the preceding text. The DNLS display, on the other hand, does not show more than one page at a time, and shows the statement currently being entered at the top of the screen while preceeding statements may not be visible. However, it is far more powerful for editing text -- changes are actuated by merely pointing to the desired location on a page. Restructuring is greatly facilitated by the capability to change views rapidly. (This will be discussed further in the section on display effects.)

It is interesting to note that freedom and flexibility seem to require structure, rather than being inconsistent or contradictory with structure. The ability to position ideas so that their relative importance is clearly shown, to control what level of detail one is viewing, to show trees of relations, is crucial to the flexibility gained by AHI. The utility of the addressing structure terminology, the various informaton units, etc., is illustrated by the tendency of the AHI language to creep into the everyday language of AKW's. For example, "Well, 'expunge' that file or 'delete plex 1', it was rejected...."

Freedom and flexibility are not limited to individual usage of AHI, but are extended to groups, teams, and the organization through the interpersonal communication facilities.

Use of the Communication Facilities

There are two specific sub-systems for on-line communication (part of the TENEX Executive software) and an extensive communication capability as part of the "Journal", a subset of the Dialog Support System.

"Send Message" permits message transmission by entering a literal and the names of any number of recipients at any node on the ARPA Network regardless of geographical location or use of AHI. The message is automatically sent to each user noting "copies to (username)", subject, and title. Notification of the recipient occurs with "you have a message" upon initial System log-in..

The "Link" command ties together two (or more) terminals so that messages may be transferred or one user may observe while the other works. "Advise" may be invoked enabling one user to work on the other's files thus facilitating a shared control over the editing, viewing, etc. This is the basis for on-line conferencing and is most useful in the display version of AHI with a supplemental audio (phone) link.

The Journal System is a collection of tools and procedures to manipulate documentation. Th user may essentially send any on-line textual entity, a message, a letter, a document or a book, to any number of users in any format merely by specifying the initials (id's) of the recipients. Distribution, recording, printing, mailing, library filing, and indexing are handled completely automatically with numerous options for the author.

These subsystems can be activated at any time. Journal and Send Message will deliver the item to a specified file (analogous to a mailbox) belonging to the receiver. Any amount of information may be so transmitted almost immediately for the recipient's perusal at his convenience. Again, this speed and ease appear to encourage "mailing" information.

We have found that the message sending feature is analogous to sending memos and has similar characteristics of ease and convenience, although it tends to be less formal. It is an important advantage that the receiver does not have to be on-line at the time. We are able to retain copies of the messages when they are printed out for reading or by inserting them into the appropriate subsystem. However, they usually are not retained by the recipient.

Messages are transmitted more easily than memos in that they do not involve paper processing, a secretary-typist, or addressing and mailing. We have found that they are sent in situations where no written communication would have been used otherwise, resulting in an increase in communication, especially vertically within the organization.

A manager who is usually difficult to reach due to meetings and other preoccupations can be easily notified. Although advantageous from this standpoint, messages are easier to ignore due to the tentativeness of the computer storage. A memo or letter is a little more demanding -- perhaps due to its physical presence.

The interviews of users have surfaced an important potential disadvantage. The use of the message System can tend to depersonalize communication or at least substitute for face-to-face interaction (see Section 5, "Communication Tally"). This is in large part due to its ease of use as an alternative or substitute for face-to-face communication as was predicted by Turoff (1972). For example, it may be selected as the mode of interaction because of a distasteful or negative content. The magnitude of the problem is difficult to ascertain. If it is significant, a negative shift in attitude toward the System might occur. This was not detected by the attitude measures reported in Sections IV and V.

The Journal System is being used ostensibly as a computer based mailing System for handling written communication of longer lengths. A hardcopy can literally be mailed but most of our users read their "mail" on-line using the easily executed retrieval commands.

It also has a message sending capability where, unlike the TENEX Send Message feature, messages are permanently stored, indexed, cross referenced, and catalogued. This is part of the Dialog Support System which has a potential impact much beyond that which we have explored.

With few exceptions, the population has not been using the Journal for dialogue support. The Journal is perceived as a place to store items of permanent value, which is usually not felt to be the case with messages. This may represent a reluctance to store routine transactions -- it is feared that they may return to "haunt" the originator.

The lack of understanding of the purposes and operation of the Journal may be more significant. "Dialog Support" is definitely a clue that continuing interactions might be recorded much as are the minutes of meetings. Not only does this provide the communicators with a history of transactions relevant to certain subject matter, but it provides the using community with an insight into developments that otherwise would have remained obscure.

The Augmented Community based at SRI is facilitated by the dialogue record, as this population will probably be with additional experience. Links (addresses that may be activated to load the information specified) are imbedded in subsequent dialogue records providing cross references to previous or relevant transactions. Thus, an interested party may follow the progression of transactions at SRI and quickly grasp the "meat" of the issue.

The use of link addresses may be supplemented by simply reading others' files. File read access and sharing has not been used as extensively as expected (our people tend not to be nosy....) A few of the users have perused others' files to learn of their doings or to answer a pressing question in their absence. By and large; however, this access is limited to copying some information that was known beforehand or responding to specific requests. This will be described in the portion of this paper dealing with effects on the organization.

Linking (note the entirely different use of the term) may be compared to a telephone conversation. The significant difference is that linking is more convenient when a user is on-line.

As mentioned above, when an AKW is on-line, other interactions are resisted and interruptions are discouraged. However, it does not seem to constitute as much of an interruption to engage in dialogue through the terminal. The novelty of this means of interacting may have some effect on its attractiveness. It is unique in our experience. It has the tentativeness of oral communication, but lacks the paralinguistic, non-verbal cues that would be transmitted via the phone. It has the immediate appearance of being a written communication; however, it differs in permanence (there is no way to store the transaction except to retain the teletype paper), immediacy, spontaneity, and its real time interactiveness. There is no time to peruse the communication or deal with written text since the recipient is reading it as it is being typed. This results in a stylistic difference which requires, among other things, an explicitness not inherent in oral communication, e.g. humorous jesting has to be labeled with a "ha, ha" or something similar to ensure correct interpretation.

Linking has been used extensively as an integral part of the AHI System. It is important to note here that although neither Send Message nor Linking are unique to AHI (they are available on other computer systems), usage appears to be dependent upon the design and purpose of the entire System. If the System were not employed to accomplish the daily knowledge work of groups, it is doubtful that either feature would have any significant utility. Both features are available for immediate use if the AKW is on-line and the need arises. We have linked among ourselves and with various users on the Network including our colleagues in Washington, D.C., and the team at SRI. In many cases contact occurred where there otherwise would have been none, thus promoting teamwork.

The Linking feature is being used within the teams for short, extemporaneous questions and comments. Surprisingly, Linking is utilized when AKWs are within close proximity in the same building, in neighboring rooms, or even within the same room. Novelty might play a part in this, but usage emphasizes the ease and convenience. It can be concluded from our observations that, as with Send Message, communications occurred where they would not have otherwise.

Effects on Groups and Teams

The System facilitated interaction within teams independent of geographical location. Although this was optimistically predicted, the nature of the teams is different than expected. The teams centered around common problems, or at least tasks of mutual interest to the members. The novel outcome was that people within the same organizational unit did not exhibit any increase in unity, or relate experiences that would indicate increased group identity. The subgroups remained isolated from each other when the user population was expanded to the present size (at the outset of organizational implementation). This was the case even when the subgroups were located in the same room, and it probably was related to the level of System usage within the respective groups.

System use as a communication medium on more than an occasional basis appeared to be a function of the level of usage in general, subject personality, and the group dynamics. It is clear that these factors cannot be dissected: they are intertwined to a degree that would require analysis beyond the scope of this study. The behaviors are salient, however.

Those subjects who did not access the System on an almost daily basis showed little use of the communication facilities to interact with peers. The primary use was as an automatic typewriter or text editor, and did not represent the addition of communication channels.

It is difficult to conjecture about which comes first, a high enough level of usage or appropriate individual characteristics, but differences between peer subgroups based on personality, particularly the leader's, were closely related to System communication activity.

There were two subgroups within the user population aligned on the basis of a specific technical area. One subgroup was tasked with System implementation--development and consequently were more likely to use it for communication due to their higher level of involvement, the more serious way in which they perceived the System, and the subsequent heavy usage. The development team also needed to interact with other AKWs at the ARC to solve problems and accomplish contract administration. Since these important functions of coordination and joint effort were more easily carried out through the System, a strong incentive existed for this subgroup to use the communication tools as opposed to the other subgroup.

Another factor involved the managers of the two subgroups within the user population. By contrast, the other group (which experienced much lower use levels) was more homogeneous in background, location, and much more closely aligned with the leader. This case involved different managerial styles at the subgroup leader level, different histories, and different physical locations.

This subgroup worked with their leader who consistently represented them to higher management. They had more frequent meetings and were physically colocated for most of the investigative period. This was not totally a function of personalities, but resulted from the group's history as well. The subgroup as an entity was merged into the group or "section" in a reorganization that occurred some time before this study. Thus, group identity and cohesiveness were reinforced.

The AHI Group, as the development subgroup was called, was headed by a much more laissez faire individual who had been transferred into the subgroup immediately prior to the test period. He was located in a separate room and was tasked with learning to use the System. The former subgroup leader remained within the subgroup and retained his position as contract monitor for the AHI project. The new leader was involved with social relationships based on his former positions. The AHI subgroup members had quite varied backgrounds as well.

Although the numerous and complexly related factors limit generalization, there are some important conclusions. Group structure has a strong impact on usage for communication. The personality of the leader becomes increasingly important with stronger group identity, which can be traced historically. The obvious prediction that the larger the relevant community of a group using AHI, the more that communication will occur was demonstrated by the relative usage of these two subgroups.

Channels of communication that did open within the organization were based on training requirements and usually consisted of help from the more experienced users to the neophytes. Of course, the observer opened channels in order to gather the reactions of up-and-coming users. These spurious channels were certainly not representative of improved communication.

Judgement of this lack of increased interaction across task boundaries as an insufficient outcome is unfair. The task structure within the organization did not change. Individuals and subgroups continued to work on problems in separate areas of specialization thus minimizing the need for horizontal communication.

It is encouraging that the consistency and amount of communication within a priori clusters of AKWs noticeably increased, especially the vertical channels, which will be discussed in a separate section. The Journal was the primary vehicle for sending messages, documents, interesting articles and references, plans and programs, copies of correspondence for non-AKWs, minutes and agendas of meetings, etc. Where these written communications might have occurrd on a chance basis before, they were duly sent to the concerned team members and stored for usage through the Journal.

Team collaboration was very evident when an individual was in need of additional resources outside his own "information space". During the preparation of briefings, and papers on related topics, individuals drew directly upon the work of colleagues by either using their files in the briefing or by moving the appropriate information directly into their information space.

An exemplary transaction involved the development of a Technical Planning Objective intended for several levels up in the management hierarchy. The responsible writer generated a draft of the document covering all areas even though some individuals were not present. Then, via Send Message, he notified those people to examine the document for comments, and revise their particular portion. They simply copied it into their working space, rewrote as appropriate, and moved the finished product back into the master document.

The most extraordinary channels opened were those with SRI, a continent away. Concerned individuals were able to collaborate on papers for conferences, proposals for funding, and the necessary support of AHI users.

One case involved higher management at RADC (the division level) which requested a paper be submitted for a conference within a deadline of a few days. Consequently, the paper was coordinated, formats and content agreed upon, and a final copy printed in the manager's office, on time in spite of the mails.

A similar situation was initiated by the California based AKWs. An annual technical report by SRI(ARC) includes a discussion of the progress of the work ongoing at remote user cites including the cite where this study was took place. A draft of the report was made available via the on-line sharing of files, and the comments of the user cite were sent through the communication facilities of the system. SRI then re-examined it, the process continuing until it satisfied both parties. The ease with which revisions are made with real time interaction, not involving the preparation and mailing of written documentation, is quite apparent with these important, lengthy papers.

Perhaps there will be increased communication between subgroups with more time and need to interact with others who are "on" the System -- a larger community. For the present, however, satisfying teamwork (teams exist across group and srcubgroup boundaries) on a given task is facilitated by the ease and timeliness of AHI.

Organizational Effect:
Changes in Vertical Communication

Predicted problems

The problems that were anticipated are discussed here to alert the reader to the cuing which may have biased our observations. It was predicted that managers would be hesitant to access the working files of their subordinates because of a kind of psychological anxiety about discovering something they should not see, and the potential overload of detail and sheer volume of information.

Managers above the immediate supervisor (already an AKW) would be reluctant to acquire the necessary skills because of the interruption of their tight schedule, the ease with which they can assign jobs to others, the nuisance of sitting down at a terminal, especially with the numerous routine interruptions, and the fairly habituated mode of solving problems through conversation (see Conrath, 1973).

Engineers at the "worker" level would experience some reluctance to enter files into the System where they might be perused by a manager prematurely. The file access controls would be used reluctantly.

These predictions center around the problem of changing strongly ingrained work habits. There are numerous additional predictions which could be made; however, this should adequately indicate the expectations generated by experience to date.

Traditional Patterns of Organizational Communication

The patterns of communication before AHI were typical of any large business or industry where the majority of people are scientific/professional. The patterns were dependent largely upon the formal authority structure and the task assignments.

A "section" consisted of about 18 persons supervised by a "section chief" who represented the first official level of management. A pseudo management level between the section chief and the "worker bee", was called the group level, and was based on a specific System development activity which was the primary function of that group as discussed earlier.

The section chief in this population managed in an easy going way where the primary means of direction were through scheduled meetings (rare), chance meetings, and direct contact. Few, if any, memos were ever used. Return communication to the manager was through the same means with the addition of periodic required status reports. An open door policy (and first name informality) were the norm. Thus, a loosely knit structure existed at this level where much of the vertical interaction was by default. Directives--requirements which came down from higher levels were usually passed on by word of mouth.

New patterns

The most noticeable change resulting from System implementation was the extensive use of Send Message. The section chief has been using this capability to schedule meetings, respond to questions, and make requests. Message traffic has been heavy and effective, even at early stages of its use. The most important usage has been to contact a subordinate who is not available at the time in an informal manner without the necessity of written records. Thus, the overhead in resources is low.

Scenarios of situations in which the message feature has been used to advantage are numerous in the chronicle. Quasi-official vertical communications are occurring where they might not have been possible.

For example, the third level manager was able to work directly with the first level manager, the section chief, in obtaining a guest speaker at a professional conference. In this case the second level was not involved as he would have been through the traditional chain of command. Arrangements for guests, etc., were made in the same manner.

The System enables messages of an informative nature, not requiring action, but increasing the effectiveness of the recipient, to be sent directly to him without the usually prohibitive problems.

The Journal System has been appropriate for document coordination through the "chain of command". It has been relegated to more formal documents in most cases. The major power has been realized when lengthy documents must be revised numerous times to satisfy managers.

A recent plan to procure additional terminals is a case in point. Over a period of seven working days a plan was prepared and rejected as "too all encompassing". It was prepared again and met upon. It was revised as a result of the meeting. A tertiary revision was made as a result of the minutes of the meeting, and submitted to the Division Chief in finished form.

Another instance involved the creation of special working documentation which has been created for management to provide an up-to-date description of research and development "efforts". These were prepared by the individual in charge and could have represented a procurement, particular investigation or development activity.

The procedure utilizes the editing power of AHI between users' directories. A standard format is copied by the individual who then "fills in" his information. Previously, any such periodic (monthly) and lengthy paperwork would have to be retyped completely after updating even though much of the actual verbiage remained the same. Now, revisions are entered on-line and the finished product is sent to the manager through the Journal along with a hardcopy printout for backup. A marked increase in the promptness with which this kind of job is completed attests to AHI's effectiveness.

This is an especially good example of information availability to augmented managers. The on-line effort description may be read at any time, whether the originator is available or not, including the latest updates. "What's going on", a question so often asked by managers, is easily and quickly answered by procedures such as this.

Trip reports, a standard government form, are also handled in this way. Availability to team members and other interested colleagues is an added advantage, especially for establishing contacts.

Minutes of meetings, whether held locally or on a business trip, are entered in a commonly labeled file in each user's directory. The standard format again provides an easy way of employing a common structure to prepare documentation for management. The Journal's library capability is depended upon to catalog and store index citations to these documents, thus supporting the filing as well as vertical communication activities.

Vertical communication has also been facilitated through the sharing of special, "open" files. "Open" refers to files that have been created with read and write permission for the organizational unit.

A file called "Staffmeet" is used by the section chief to record items of interest to his subordinates by membership in one of the two task groups. Occasionally, items are entered that are for one or two individuals. The file is continually updated (weekly, as a minimum) and may be reviewed at any time. The real value is the opportunity for the subordinates to add comments, answer questions, or add items of general interest at any time. The file has become a supervisor's meeting in absentia, and is retained as a record of the continuing dialogue. This file seems to have become a highly efficient means of conducting the business of the organizational unit.

Another file is used to record, for management, any news items for potential inclusion in an administrative newsbrief. Imagination is the limit where open file usage is concerned. It is not clear why this channel is so attractive, but its use, in addition to the more formalized communication features, provides a complete vertical communication tool.

To this point we have been discussing experiences regardless of terminal type. It is most likely that a display terminal would not appreciably change communication usage, but it is certain that it does affect individual performance as borne out by the subjects that have become proficient.

The Display On-line System versus the Teletype

The Display On-line System (DNLS) constitutes a separate subsystem of AHI. It includes human engineered devices that result in maximum ease (within the state-of-the art) of man-computer communication.

A hand held, cursor control transducer, the "mouse," enables an AKW to point to any textual entity on the TV like display. He then can perform any of the operations that were available in the teletype version without further addressing. Any editing or other changes are immediately visible. To supplement the standard terminal keyboard, a "binary keyset" may be used to key in alphanumerics much as one would play chords on a piano.

The screen shows a number of feedback "windows" for commands, addresses, viewspecifications, literal inputs, etc., in addition to the display of an approximate page of a textual file. Commands that point, delete, and execute are actuated by buttons on the mouse (see Engelbart, 1968).

This brief description of the highly interactive and optimized interface will hopefully establish the setting for the particular effects of DNLS. It is through DNLS, it can safely be said, that the full potential for individual augmentation can be realized. Much of the foregoing discussion might be revised to show more positive ramifications if every user had a display terminal. It is hoped that the additional effect and capabilities experienced beyond the teletype usage will be established here.

No one has tried to learn DNLS without first becoming reasonably capable with the teletype. The experience of those who have learned both indicates that it would be difficult to start with DNLS, although we have yet to show this. The present cost of the display terminal ($15,000 per IMLAC with mouse & keyset) has encouraged the emphasis of teletype access for the time being.

One subject, who has been using DNLS for about 6 months, describes the effect quite vividly as a "trip" that is addictive.

> When DNLS is flying so am I! This causes a noticeable change in my behavior. I am extremely reluctant to break for lunch, social conversation, coffee, the 5:00PM whistle or weekends. I smoke more (unconsciously). This is making me an emaciated, constipated, emphysematous, introvert; who is neglecting his family.

He offers the following analysis using some learning theory concepts. He states that the use of DNLS is self--reinforcing because it is immediate, happens often, and happens at the level at which the behavior occurs. Less frequent, but perhaps more powerful reinforcment is obtained from coworkers -- "Oh I didn't know you could do that!" -- which gives one a feeling of being on top of things, one-up-man-ship, superiority, etc.; and it is obtained from bosses in a similar way. In addition, the ability to respond quickly, often before the question is asked, engenders admiration. My personal experience has been very similar to these perceptive responses from this member of the populaton.

The increased speed with which one can address, change text, and actually see the change, results in a dramatic experience for the skilled user (there are three in our population). Pointing to a link address not only displays the addressed information at the push of a button, but also controls the viewspecification or "window" through which one looks at a body of information.

Link addresses are entered as any other text. Thus, the AKW typically enters links as he develops information units which are then linked together (cross referenced) including the specified views of the information. For example, the user may need to refer to an outline of the document he is massaging. By actuating the link he may display a toplevel view. The System stores up to five views at a time which may be quickly recalled as needed, thus facilitating return to the detail and location where the AKW was originally working.

In the same manner he can refer to any information unit for reference, which includes the vast Journal documentation. Or, he can "split" the screen into a maximum of four parts each representing a window -- textual units can be moved around between these. Searching for a topic area is easily done by successively showing more levels and detail in any particular file.

Displaying various windows that look into the information space is appropriate for briefings, etc., as visual aids: dynamic, computer generated "viewgraphs". The power is in moving quicky forward or backward through the aids, and making changes at the request of the audience. Movement is done by imbedding a hidden link to the next viewgraph/display.

A complete description would continue, but it defies reasonable brevity. Overall, it is as if the AKW were traveling through information space comprised of the work of communities of AKWs. At any point he can stop and utilize the information at that location or move it to his own information space from others.

One of the few notable limitations we have encountered is display recreate speed, which is a function of our terminals, transmission line rate, and System load. Even under slow conditions, a "page" is written on the screen in a few seconds. Improvements in computer hardware will probably remove even these few seconds.

This description is offered in spite of the anticipated comments about over-enthusiasm and starry eyes. How fast an AKW can "travel" through information space is surely a function of the individual and the nature of the task. Conclusions from these observations must be tempered due to the limited population size. However, these are in fact experiences we have had to date.

Population Characteristics and Effect

It was difficult to separate the influence of the job task type variable from the personality variable, but some interesting experiences were observed. Those who spent the majority of their time programming might actually have been impeded in the learning of AHI because of proactive interference. Expectations due to experiences with other systems interfered with at least one of the subjects as he tried to use AHI. The job task type profile is provided in Appendix A to aid the reader in the assessment of the results.

Summary

There was a strong resistance to changing habitual work methods and communication patterns. There were psychological as well as hardware causes for the resistance which were mutually escalating. Weak training techniques, System failures, and hardware unavailability were some of the difficulties encountered. As the problems were overcome, thresholds were observed in the way the System was used and perceived.

AHI use tended to fall into two discrete kinds, use as an automatic typewriter and, with the more advanced users, use for on-line composition. With use on a regular basis, the skills were acquired that rendered the System "transparent", so that the individual was no longer concerned with System operation. This tended to free him for spontaneous, creative work while the rules of operation and syntax remained subliminal in much the same way as with the use of language in conversation.

Observations of the population subsequent to training noted three areas of effect, (1) on the individual, (2) on groups and teams, and (3) on the organization.

Hypothesized effects were not entirely realized; however, they may be with additional time and System development. At present there are changes that point toward that realization. Individuals experienced an unprecedented flexibility and involvement with textual information through powerful features such as the link address, viewspecification System, and information structure.

This power facilitates the construction of an information space which may be easily and rapidly communicated and shared with other AKWs to promote dialogue among task teams. The communication facilities, Send Message, Linking, and the Journal System, were employed to create new patterns of communication that would not have been attained through alternate means. The resultant documented team collaboration extended to the organization.

Vertical communication improved, as new channels were opened and formal channels were modified from the traditional patterns. The System capabilities became a new management tool which increased openness without a loss of efficiency. A number of examples of this were discussed, including collaboration with geograpically distributed groups and the sharing of special dialogue files.

Display terminals were available to a few of the population promoting a fuller realization of the impact of AHI aided by human engineered interface devices. A dynamic information visibility was achieved by utilizing "windows" into the information space. The result was like traveling through the dynamically structured information space of a community of knowledge workers with such rapidity and ease that it was almost addictive to the user.

The effect of the significant changes in the work methods and communication behaviors that were observed on general attitude are reported in the next section.

(Note: The author's publication, "Experiences with an Augmented Human Intellect System: Computer Mediated Communication," Proceedings of the Society for Information Display, Second Quarter, 1973, is based on this section.)

Section IV
ATTITUDE CHANGE

General Attitude Toward the Technology, the "T" Questionnaire

The 30 item "T" Questionnaire was designed to measure the population's attitude toward the general technology represented by the AHI System. It was administered to half of each of the user and nonuser groups as a pretest and to all of the population during the posttest (see the Design Format in Section II). The questions dealt with concepts that were known to the population and that they could respond to on the pretest. The concepts (factors) that subjects were asked to respond to are as follows.

A. Automation in general

B. The library use of computers

C. Computers in general

D. Computer use to accomplish paperwork

E. Privacy of information stored in computers

F. Typing into the computer

G. Computers as an aid to thought

H. The ease of using computers

J. Computer as a device for interpersonal communication

K. Use of computers to assist in meetings and conferences

The items were responded to on a Likert type scale that included four positions, strongly agree, agree, disagree, strongly disagree. The selection of this particular scale was to force a choice between positive and negative responses. This was based on the behavioral supposition that any latent attitude that might not be strong enough to influence a selection other than neutral, would be manifested if the subject were given no neutral alternative. This procedure did seem adequate. The total score, rather than item scores, was of interest based on the assumption that the design criterion of consistent questions had been met. A split half reliability test showed a high reliability (0.74) during the pretest.

Scoring was done by assigning a value of one to the most positive response per item, strongly agree, through a value of four to the most negative value, strongly disagree. The total scores were then used for the statistical analysis which was done by the Psychological Research Center at Syracuse University using their library programs.

Attitude Shift Across Groups

The most important results of interest were any differences in mean attitude scores due to System use, the independent variable. Differences in attitude among all groups were also measured to provide a control for spurious variables and test effects. Thus, a related t test was used between the pretested experimental group (group I) and the posttest experimental group that was pretested (II); and the pretested control group (IV) and the posttest control group that was pretested (V). An unrelated t test was used between the pretested experimental and the non-pretest experimental group (III); and the pretested control group (IV) and the posttest control group without the pretest (VI).

The results are shown in Table 1. There were no significant changes in the mean scores among any of the groups except the pretest control group and the non-pretested control group which showed a more negative attitude in the posttest control group. Part of the lack of significance is due to the small N, which allowed few degrees of freedom.

Table 1.
"T" Questionnaire Statistical t Tests Between Groups

Groups	II post exp 1	III post exp 2	V post con 1	VI post con 2
I pre exp 1	-0.987 N = 9	1.569 N = 18		
IV pre con 1			-1.560 N = 6	3.490* N = 17
II, III, V, VI	F = 2.491, analysis of variance across four groups			

Further examination of the results shown in Table 2 confirm the t test. The standard deviations are similar in all the groups, at least enough so that the means are roughly comparable. It is immediately obvious that there is little difference between groups I and II due to the independent variable. There is a slight difference between these groups and the third user or experimental group, III. Any difference that approaches a standard deviation among the groups, approximately five raw score units, is worth noting. The more positive score in the post user group, III, does approach this level. The fact that it is more positive is encouraging for two reasons, first, use of the System did not result in a more negative score. Second, the more negative score for the pretested users on the posttest can be associated with test effects.

Table 2.
"T" Questionnaire Means and S.D. for All Groups

	"T" Quest		OCI			
Groups			Factor 1 Dev		Factor 2 Con	
	X	S.D.	X	S.D.	X	S.D.
I Pre X 1	73.99	4.44				
II Post X 1	75.77	6.37				
III Post X 1	69.11	7.60				
IV Pre c 1	63.24	5.73				
V Post C 1	67.85	6.62				
VI Post C 2	75.33	7.44				
Additional	65.33	4.64				
II III V VI	72.26	8.00	153.86	12.69	82.26	10.34

X = Experimental   C = Control

Test effects may also be associated with the difference between the pretested control groups, IV and V. The difference is more than four and could be associated with maturation as well. The statistically significant difference between the pretested control group and the posttest only control group may be attributable to spurious factors (e.g. personality differences). What it does indicate, however, is that attitude tended to become more negative due to maturation. The group VI score is very similar to that of the pretested users groups, I and II. It is significantly more negative than the posttest only user group, III, showing that a more positive attitude may be exhibited toward technology by a group using the System, than by a like group without exposure to the System. The "additional" group, composed of individuals who became users later in the experimental period, corroborate the more positive scores for users.

The pattern of results ascertainable from table 2 shows a slight negative shift in scores from the pretest to the posttest in both the experimental and control groups, which probably is associated with test effects. The posttest only groups (III and VI) showed that users were explicitly more favorable in attitude toward the technology than a like control group.

More individual subject scores shifted negatively from the pretest to the posttest thus corroborating the differences detected by the examination of mean group scores (see Appendix J; note that a negative z score is positive relative to the mean for that group due to the scaling -- coding procedure used).

Correlation with the Organizational Climate Index

The purpose of the OCI in this investigation was to detect any relationship between the attitude toward the working environment and job, and the attitude toward the technology and the System in particular. Statistically, this was accomplished by performing a correlation between the scores of subjects on the two third order factors of the OCI and the posttest T Questionnaire (groups II, III,V, VI). Table 3 shows the results.

Table 3
Correlation Between "T" Questionnaire and OCI

"T" Quest Posttest	OCI			
	Fac 1 "Development"		Fac 2 "Control"	
	R	sig	R	sig
(Groups: II III V VI)	-0.662	.001	.5357	.004

23 Ss were tested on both the OCI and "T" Questionnaire

The OCI factors were (1) development, and (2) control. Briefly, development represents a third order factor comprising those items that indicate a positive attitude toward the subject as a worker and his working environment. A high score would show that an atmosphere existed where the subject feels he can develop, and is not unreasonably restricted. Control represents the opposite, where unrealistic, unfavorable restrictions exist on the individual's development and progress.

The second order factors that comprise the third order factor for development are: intellectual climate, organizational effectiveness, personal dignity, and orderliness. The control factor is comprised of work and impulse control. The work factor represents an excessive work orientation and is not associated with individual or organizational effectiveness (Richman and Stern, 1969, 35). The 30 first order factors provide further clarification of the third order factors which are used here to establish subject scores (Richman and Stern, 1969, 65).

The results were as anticipated, the scores on the OCI factors significantly correlated with T Questionnaire attitude. (The negative correlation coefficient is due to the fact that a low score is positive on the T Questionnaire whereas a high score is positive on the OCI factors. Thus, the significant correlation between the control factor and the attitude is in the expected direction.

The moderate but substantial relationship shown indicates that individuals who perceive the job environment positively, and in general have a healthy perspective toward their job, tend to perceive the general technology in a similarly positive light.

The OCI also provided a check for significant differences in individual attitudinal structures across any of the groups, particularly the control versus the experimental groups, that might color their perception of any job related behaviors. The results indicate that there were no significant differences across groups in perception of the organizational climate. (Note: These statistics are not included in this report due to the private nature of the scores which may reflect upon individual subjects.)

Correlation of "T" Attitude and Intensity of Use

The O Questionnaire (see Section V) included a question designed to categorize the subject's estimate of the intensity of System usage on a daily basis. The categories were (1) less than an hour per day, (2) between 1 - 2 hrs. per day, (3) 2 - 3 hrs. per day, (4) 3 - 4 hrs. per day, and (5) more than 5 hrs per day. The Q Questionnaire was given only to System users as a posttest (see Section V). It was expected that there would be a relationship between the amount a person used the System and his attitude toward it. One can only speculate about which might cause the other -- did System use affect attitude or was System use a function of attitude.

The N of 14 is less than originally planned. This is due to attrition and the fact that this test was given to persons who had used the System on some regular basis, at least once a week. It was felt that this level of usage was necessary for a subject to be classified as a user for the purposes of the Q Questionnaire. (The negative correlation coefficient is due to inverse scaling on the two items; attitude was more positive with a lower score and intensity was less with a lower score.)

It was clear that there was a moderate correlation indicating a substantial relationship between intensity of System use and attitude toward the general technology after use (see table 4).

Table 4

Correlation Between "T" Questionnaire and Intensity

"T" Quest Post Exp	Question # 23 "Intensity"	N = 14*
	R	sig
Groups I and II	-0.564	.018

*14 Ss had an adequate use level

The results of the "T" Questionnaire, although showing no significant difference due to the independent variable, do provide insight into the relationships between individual attitude and the disposition to use effectively a technology such as the AHI System. These relationships are elucidated by the data obtained via the additional instruments, the Q Questionnaire and Proficiency Test, which are discussed in the next section.

SECTION V
STRUCTURED OBSERVATIONS AND COMMUNICATION ANALYSIS

Content Questionnaire ("Q")

This questionnaire was designed to obtain reactions to specific statements and answers to specific questions about the AHI System and the subject's experiences with it. The questions were directed at a number of areas including effectiveness in terms of accomplishing paperwork activities, effectiveness of communication tools, attractiveness as an alternative to handwriting documentation drafts, general feelings about the System, use intensity, terminal use, quality implications for thought and written documentation, System resource availability, and predictions about future attitudes and experiences. This instrument was a direct method of obtaining subjective responses about the System's effect. It was administered to the user group only at the end of the experimental period.

Item Discussion

There were a total of 23 questions, 19 of which used a Likert type scale (see Appendix G). An analysis was done using correlations between similar questions, questions which could indicate causal relationships, and major variables -- three of which were measured by this questionnaire: System availablity, intensity of use, and terminal type.

Question one was designed to compare actual user experiences with their expectations before they were in contact with the System. The System was introduced primarily as an aid to paperwork processing and the concomitant functions that are accomplished in the daily work routine. This included text editing and the preparation of longer documentation such as reports, etc. The emphasis on communication via the System was not developed at the beginning of implementation; thus, this question would tend not to detect expectations about communication usage. The majority of responses were neutral, while the remainder, with one exception, were mildly in agreement. The large neutral response was probably due to an embryonic concept of the System design goals and purpose. There may be a strong relationship between this response and the usage experiences mentioned earlier, which show a marked threshold during the evolution in usage from an automatic typewriter to on-line composition. That threshold may be a function of understanding that the System is capable of more advanced applications than the text editing associated with an automatic typewriter.

The change of attitude resultant from use that was detected by question two, is one of the most significant findings. This response indicated that the System was positively reinforcing for about 77% of the users, with almost a quarter strongly agreeing. This might have been largely due to negative expectations initially, resulting in a positive shift after a more positive experience. However, the "T" questionnaire pretest showed that at least the attitude toward the general concept of the technology was not negative a priori. The general expectation was neutral, thus negative expectations do not appear to be the causal factor. Number eight corroborates this by showing that the subjects anticipate (over 3/4 of the subjects) that their opinion will become more positive with additional use. This anticipation was stronger for those with limited experience. Apparently, a majority feel they have limited experience as indicated by their positive response to number eight. A five by five contingency table (see Appendix F) shows that all subjects answered these questions within one interval, with the largest group answering "agree" for both.

The positive correlation between number seven, where 47% indicated that they were more efficient, and number eight, where the majority expected that more use would increase their opinion, indicates that the subjects are experiencing reinforcement (see Appendix F). Number three detected one of the sources of reinforcement, a reduction in throughput time, although it was not sensitive to an increase in throughput time if there was one. It is significant that more than half the subjects found that throughput time decreases when using the System to prepare paperwork. A contingency table shows a strong correlation between number three and number seven, which corroborated that they were more efficient (see Appendix F). These responses stress the editing capabilities of the System, not the communication uses.

The reasons for this increase in efficiency can only be interpolated from the other responses. Number eleven indicates that it is not due to less need to write longhand drafts. However, number fifteen, which showed that a majority felt that their thinking about written work done on the System was improved, offers some explanation. Only 18% disagreed with the statement that their thought was enhanced. Number fourteen indicates that a majority do not perceive the System as being effective for all job tasks, thus supporting the conclusion that the noted increases in effectivenes are specifically for the production of typewritten material. Number twelve again discriminates between overall effectiveness and paperwork activities -- a majority expected that paperwork could be accomplished more effectively by anyone who used AHI.

The questions about System use as a communication tool, numbers 17 and 18, show that a majority do not find this has been an important feature. Observations indicate that the communication features in general were not used extensively, thus establishing the cause for a majority response of neutral. The proficiency exercise showed that a significant number of subjects did not know how to use the communication facilities (see below).

Number five appeared in retrospect to be a confusing question, but it did indicate that the majority found reasons other than a lack of written material for not using the AHI System.

Although there was considerable support for an increase in efficiency, number six clearly showed that the large majority saw no quality implications for AHI, even though they saw an enhanced thinking ability (number 15). Observation suggests that causal factors might be limited experience with the System, the inability to use the display version of AHI (less than half of the subjects), and the difficulty of judging quality. In spite of these factors, the response has significant implications for individual effects of AHI: after an average of six months of use, with a majority using the System more than one hour a day at the six months point, three quarters of the subjects were neutral about an increase in the quality of work accomplished on AHI.

Number nine shows that more than 3/4 of the users see AHI as an advance in the state-of-the-art, which is both remarkable and significant in light of the fact that most subjects are in the business of advancing the state-of-the-art through Research and Development in information science. This also illustrates a disparity between off-the-cuff comments, many of which tended to be derrogatory, and questionnaire responses. It cannot be determined what role the lack of anonymity had on this positive response or any other on this questionnaire. The "back patting" phenomenon may be a factor. It is conceivable, although not probable, that the population recognized the System as an effort on the part of colleagues and as a source of funds for the organization, thus indirectly supporting them.

Probably the most difficult statement to respond to positively was number ten, which asked subjects to relate to the overall goals and theoretical foundation/justification for AHI as a unique system: that it will positively impact effectiveness in all aspects of knowledge work. Surprisingly, 47% agreed while only 12% disagreed. The neutral responses may be from those who are waiting for additional experience. Question number one seems to be related to ten in that the expectations of what the System will be ("improve effectiveness in almost everything that is job related") are slightly greater than what it appears to be now. The majority of the subjects anticipate that the System will improve effectiveness in general even though it has not yet fulfilled expectations.

Questions number 12 and number 13 clearly show that the large majority of users feel that the System has general learnability and is not limited to some select group with special aptitude or skills. This was of great concern initially due to the extensive complexity of the command structure and syntax. However, the response does not say anything about the level of use that is accomplished with "relative ease". The proficiency exercise and observations again indicate that the viewpoint of the subjects is from a limited level of expertise -- a moderate or half-way sophistication of use relative to the most adept user in the population. Nevertheless, it is important that this level of use, primarily as a text editor, is perceived as attainable by anyone.

The foregoing discussion about lower-than-expected use as a communication tool did not deal with number 16. It was almost unanimous that file sharing is an effective tool for keeping informed. This results from management usage and policy for the organizational unit, which is a function of one person. The first line manager relies very heavily on one open file to record directives, due dates, meetings, and most other supervisory matters of a general nature. This file is used by subordinates for pertinent responses and to keep abreast of what is happening to their colleagues. It is difficult to predict from this case, which appears to be very much a function of individual style, except to say that it is a communicative technique that does work (See Section III, "Use of Communication Tools").

Questions 20 through 23 were important to detect negative influences on attitude. System unavailabililty (numbers 21 and 22) would be a negative causal factor; however, a majority of the subjects found it available most of the time. Number 22 did not significantly correlate with number two, which detected improved attitude with use. Among the population as a whole there was no correlation between reactions to the System and availability. However, in certain individual cases it was found that those who had a terminal available less than 40% of the time scored below average. This is more important when it is noted that the same subjects responded with low scores on most questions.

A majority found the Imlac CRT more effective to use (number 20) but this is more an indicator of those who could use the CRT rather than an assessment by everyone -- it was not available to more than 40% of the users. It can be predicted from observations that had everyone used the CRT, they would have preferred it unanimously.

The total score on the Likert scaled questions, one - 19 (values: strongly agree = 5, strongly disagree = 1), did not correlate with either 21 or 22. This method of scoring was not statistically sound (the items were not designed to measure the same thing) and was only done to see if any additional pattern could be detected. The Z score of the summated scale questions did; however, provide a check on the interrelationships between attitude and perceived effectiveness. Those who did not perceive an increase in effectiveness had negative Z scores, and the two cases where the Z score was below -1 also had the lowest scores on effectiveness. The relationship was the same for the high scores. An "eyeball" of the tabular data (Appendix J) indicated that the four effectiveness questions varied with the total score.

There were two clusters of items that were noticeable in the data, "projected attitude" and "effectiveness". The attitude questions (numbers two and eight) were consistent within the two items, with a high intercorrelation (see Table 5), but were not consistent with the total score or the effectiveness questions. That is, a high combined answer score could not be used to predict high scores elsewhere. The most likely conclusion from this may be that the attitudes represented a predictive frame of reference, whereas the effectiveness and overall scaled questions were retrospective. This is consistent with the content of the questions.

The effectiveness cluster (numbers three, seven, twelve, and fifteen) also was based on a high correlation among the constituent questions (see Table 5). Thus, subjects who scored highly on this factor were indicating a strong response about the System's effectiveness. The scores on this factor varied in much the same manner as did the overall score on the Q Questionnaire, as indicated by an eyeball of the data (Appendix J). More importantly, there was a correspondence between the low scores on the attitude factor and the attitude from the T Questionnaire. In fact, if a subject was at either extreme, all the scores tended to be at the same extreme. Thus, we can see some consistency between general attitude, projected attitude, effectiveness, and the total evaluation of the system, although nothing approximating statistical significance.

Table 5.
Q Questionnaire Item-with-factor Correlation

Items	Factors	
	Attitude	Effectiveness
2	.799	
8	.838	
3		.745
7		.825
12		.840
15		.839
Factor mean	3.92	9.93
Factor S.D.	1.10	2.74

Summary of Questionnaire Findings

The questionnaire results were generally consistent with the predictions of system effectiveness for individual use. The significant exception was in terms of quality, which was found not to be enhanced. Thus, effectiveness cannot be defined as higher quality output in less time, but simply increased output (or throughput) with less effort. Attitude and perceived system effectivenes were found to be consistent, which was a major methodological hypothesis. Further extrapolation from the responses about present effectiveness and predicted effectiveness indicated that system use is rewarding. Experiences were perceived as limited, but they must have been reinforcing in order for the majority of the respondents to anticipate an improved attitude.

The questionnaire in general, and the questions concerning intensity of use, were consistent with measurements of proficiency. This provided strong evidence to support the conclusion that subjective responses are a valid means of ascertaining the utility of the System.

TNLS Proficiency Exercise

The proficiency exercise or "test" was designed to measure the ability of a user to edit a paragraph of text, to link to another user, send a message and transmit the corrected text through the Journal (See Appendix E). The exercise was presented to each user on hardcopy, with the unedited and a corrected version of the text. The errors were marked on the unedited text -- proofreading time was not of interest.

The results of the exercise were tabulated by counting the editing commands that were used by each subject, noting the time required to complete the editing, and the number of errors in the edited text. Subjects were asked to record the time by executing a special control character which printed the total connect time to that point. (At the time of these tests, the System did not provide an automatic record of the time or the editing commands used.) Interruptions were noted in the same manner. Errors in the edited copy were compensated for by adding one minute and two commands for each error to the total number of commands used. This was based on the average time and number of commands necessary to execute the correction had it been done by the subject initially.

A rank order correlation was performed between the editing time and the number of commands; editing time and the number of months of system usage (longevity); and the editing time and the intensity of usage from the "Q" questionnaire (see Appendix J).

Results

Longevity did not significantly correlate (at the .05 level) with any other variable. This verifies intuition -- longevity alone is not sufficient to act as a causal variable. For example, a skilled user may continue to use a large number of commands, but execute them more rapidly with fewer errors; or the style of editing technique may cause more commands to be used despite greater longevity. Rather, the effect of longevity is a function of the intensity of use, e.g., certain subjects gained more skill in a shorter overall length of time due to more intense use. This initial analysis does not eliminate longevity as a causal variable but only permits the following conclusions.

(a) Greater longevity did not result in the use of fewer editing commands.

(b) Longevity did not significantly correlate with editing time, although there was a definite tendency for those with greater longevity to have lower editing times.

(c) An alternative editing technique resulted in large differences for those subjects that used it confounding the results.

The use of an editing method called "execute edit," as opposed to the use of individual commands for each editing change, resulted in a significant reduction in both the number of commands and time, independent of the other variables.

Execute edit permits a user to edit a statement while that statement is being printed by determining the approximate location of the error, and printing to that point. The error is typed over correctly, and printing proceeds until the next error is about to be printed. The procedure is repeated until the statement is complete. In tabulating the number of commands used, each correction was counted as a command in order to approximate the counting used for the usual procedure. Execute edit was concluded to be more efficient primarily because addressing the point of text where there is an error does not have to be done within the statement (execute edit only works within statements). When individual editing commands are used each textual error must be addressed before the correction can be made. Only three users employed execute edit, and all three were among the best times and used the fewest instructions.

However, when the three subjects who used this alternative were dropped from the distribution there was still no significant correlation between performance and longevity.

Proficiency as a Function of Intensity of Use

Longevity by itself was not found to correlate with skill, indicating that intensity of use was a more important factor than anticipated. The intensity, or degree of usage during the period of longevity, was measured through a direct question on the "Q" questionnaire.

The multiple choice question asked a user which of four categories were appropriate to his experience: (1) less than 1 hr., (2) less than 2 hrs., (3) 2-3 hrs., (4) 3-4 hrs., and (5) more than 4 hrs. per day.

The tabulation of data showed that the greater the intensity of use, the better the performance, particularly with respect to editing time. Statistically, a significant rank order correlation (at the the .01 level) was found between editing time and intensity (+.74).

Although there was no correlation between time and longevity, it was concluded that longevity must influence editing time, to wit, intense use over a longer period of time would make a user more proficient than would the same intensity over a shorter time period. In order to detect any relationship, intensity and longevity were treated together. The respective scores were multiplied to give a combined value which was called "longtensity". A significant correlation (at the the .05 level) was found between editing time and "longtensity" (+.67).

Longtensity represents the variable that most influences any learning situation -- the combination of the length and the number of trials. However, there was no way of accurately recording the time each subject was spending at the terminal during this time period. The System did keep records of System use time per directory, which is defined by the user's name, but different subjects other than the person it was originally established for used the directory. There was a shortage of directories as well as a need to have clerical help enter and edit some of the text for certain subjects thus adding their time to that of the subject. The shortage of directories led to a sharing among subjects who became users relatively late in System implementation.

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This sharing of directories also complicated the use of the communication facilities. In a minority of cases, it was not possible to send messages or Journal mail directly through the System because a directory is required to receive them. Although there is an alternative means of defining persons to the System (the "ident system"), that permits delivery of hardcopy through the mails and not on-line, the time lag under these circumstances is one to two weeks. Essentially, the System does not know who a user is except through the directory under which he accomplishes the logging procedure. These problems justify the use of a subject's estimate of his intensity of use and longevity.

The learning picture is further complicated by the kind of operations performed during the use period. Even though there was a high correlation between longtensity and editing time, it is not clear that the mere quantity of time will insure an increase in skill. Questions remain about the likelihood that a person will attempt to increase his knowledge by trying alternative commands, reading the documentation, asking questions, and generally exercising some creative curiosity. If he does not do these things, the vast richness of the System may never be tapped.

It was concluded from observations that this kind of self instruction is a function of individual differences, demands on the individual to produce, and the availability of help. When a subject became reasonably comfortable with a certain set of commands and procedures, in general, he was not too likely to attempt to learn new commands -- the momentum phenomenon. The particular "rut" one found himself in resulted from initial training in most cases, and was found to be inefficient for the broader spectrum of tasks found in post-training applications.

Proficiency and Communication

The most important ramification of the momentum phenomenon for this study was the lack of use of the communication facilities, compounded by the System limitation mentioned above. Many subjects attempted to send communications through the System for the first time during this proficiency exercise. Thus, the exercise became more of a learning experience than a testing device for the use of the communication tools. The one exception was the use of shared files, an important response to the immediate supervisor, and also requiring a minimum of skill. The overall results showed that almost half of the subjects were not familiar with the communication portion of the test.

In terms of this study, this is a significant confounding variable. Conclusions about AHI as a communication medium for facilitating the development of groups, teams, and the organization must be interpreted as representative of the least amount of impact possible. It is extremely probable that there would have been more use and therefore greater impact had there been a rigorous training or testing program aimed at ensuring a capability on the part of each subject to use all the tools for interaction. Rather than being a loss in terms of the study's value, this is a valuable insight: during the implementation of an AKW, steps should be taken to insure that a basic mastery of all tools has occurred.

The same is true for editing tools. Had every subject been versed in all capabilities, he would have had the "execute edit" command available to him thus improving his editing performance within individual statements.

The important finding is that after several months of use by a population there was not a basic familiarity with the communication features of the System, which represent a major power of the System. This leads to the conclusion that this medium is not attractive enough to be selected as an alternative to conventional ways of communicating by telephone, face to face contact, or written correspondence (see the Communication Tally results). In contrast to the editing capabilities, the communication patterns are engrained more deeply in psychological structures such as personality and social milieu. Intuitively it is obvious that calling on the phone or walking down the hall and dropping in are quite easy when compared to logging onto a computer system and then actuating the precise, although not too complicated protocol.

The scope of the on-line community that an individual needs to communicate with is another important factor. In this case the immediate organizational unit comprised the only portion of the on-line community that was of interest to the subjects. Had a larger number of communicants been members of the on-line community, as was the case for a few exceptions, then there would have been a great deal more motivation to communicate via the System. Geographically distributed communicants would have further increased the motivation.

The exceptions included those AKWs who interacted extensively with the California ARC utilizing all the features. A number of other users external to the population provide a twofold exception; they communicated extensively through the send message feature which was the only System feature they did use. The particular office; however, was responsible for the development of the Network as well as sponsoring the entire AKW project. This provided special motivation for them to accomplish their correspondence through AHI.

Earlier, the concept of a threshold in the transition from use as an automatic typewriter to full augmentation was introduced. The proficiency test provides the basis for the concept of a "communication threshold," a definite change in the behavior predispostions of a person that are necessary for the meaningful use of the communication facilities, not only to initiate communications but to receive them as well. The communication threshold may be passed through training and indoctrination leading to an in depth awareness of the facilities, their potential, function and usage.

Conclusions About Proficiency

Longevity was not found to be a key factor affecting the subject's proficiency. Intensity of usage played a more significant role in influencing the editing speed, which decreased as the intensity of use increased among the subjects. The number of commands did not associate with either intensity, longevity, or editing time. It was surprising that a more skilled user could accomplish the editing task with a similar number of commands, but in much less time than a unskilled subject.

The combined interpretation of intensity and longevity, "lontensity," did correlate with editing time, but it was not more significant than intensity alone. Logically; however, it must be concluded that skill is a function of the intensity of use over time, and not intensity alone as this sample suggests. We were not able to determine the point at which skill levels off in a learning curve. It was not possible to establish learning curves because of the requirement for periodic testing, which this population was not willing to accept. It is likely that longevity plays an important role intially, but after a time period such as in this study (seven months) intensity becomes the more important factor by enabling a user to retain his skill through practice. Thus we can predict that a certain amount of practice is necessary to retain any kind of competence.

An alternative editing technique, execute edit, was found to be superior for editing within statements. It would not help; however, when minor editing was required within each of a number of statements.

Evidence was accumulated supporting the conceptualization of another threshold (see Section III) to be passed while becoming an AKW, the "communication threshold." A considerable amount of momentum was found for continued use of the System as an editing device only. It is not until a certain amount of training, indoctrination, experience and need have occurred that an individual progresses to utilization of the communication tools in a meaningful way.

Communication Tally

It was pointed out in the review of literature that Conrath's method of communication analysis within the organization was the the latest development of the most appropriate technique for examining the effect of computer systems on an organization. The technique was applied to the experimental and control groups for five days at the end of the experimental period. At a meeting of the entire population called at the request of the Branch management, the purpose and method were explained by Dr. Conrath followed by a question and answer session. Conrath was called in to assist in the modification and restructuring of the tally sheet and instructions, and to lend objectivity and persuasion to the investigation. It was expected that the technique would be resisted and that every effort should be made to encourage reliable participation.

The specific goal was to measure the usage of the communication tools that the System offers and compare them with the conventional patterns and channels of communication within the organization. The administration of the technique to both the control and experimental groups provided a comparison of two like organizational units, one with and one without the System as a communication medium. The most important result was to be able to document the specific communication feature being utilized and to establish what portion of the S's total communicative behavior was through AHI.

The results were reported by Conrath (1973) in a special report. The data, consisting of the tabulated transactions for each pair of communicants were coded by mode and by participants, and by the relative position and location of each participant in the organization. Volume of communication was represented as frequency of transaction and the weighted communication. Weighting was based on an average communication event of two minutes. The average for the 3-15 minute category was eight minutes or four weighted transactions, and the average for the over 15 minutes category was 32 minutes or 16 transaction units. Thus, conclusions could be drawn from the data about the quantity as well as the frequency that interactions occurred.

The AHI modes selected during this five day period were 40% "send message," slightly less for the Journal, and relatively little for the shared file and "linking" modes.

AHI was not found to be associated with a reduction in paper flow. Rather, there was less face-to-face contact among those using the System. Telephone traffic was also less, but not significantly.

AHI was used quite extensively for vertical communication, equally as much as paper based communications. Those who used AHI also had a broader base of contacts than did those who did not use the System.

The data analyzed by Conrath is certainly not meant to be representative of the communication activity of the organization. However, it does provide some insight into the way in which the System is beginning to have an impact upon communicative behavior. The study clearly demonstrates that it is being used for the purpose of interacting vertically and horizontally in the organization. The fact that it seems to have been selected in lieu of face-to-face interactions, especially vertically, indicates that it can be used as a very personal interactive device. Whether it retains the advantages of face-to-face interaction is a question for future research. It does offer many advantages, such as the recording capability, the ability to reach through barriers to ordinary communication, such as the receiver's absence and unavailability (especially vertically), and the capability to immediately transmit.

A strong recommendation is in order based on this cross section at a relatively early stage in the development of a fully augmented organization: that a follow-up study be done in a year or so to ascertain the differences in communication pattern and structure due to expansion and a higher level of experience. Even though the communication threshold was not passed for a significant number of subjects, the significant level of communication activity leads to the prediction that a great change will result over a longer time period.

Interviews

Interviews were conducted at three time periods during the span of this study, at the outset of user training and System implementation, and during the month that fell three quarters through the span. The primary purpose of this technique was to supplement the more close-ended techniques by allowing a maximum freedom of response. The details of the procedure and the questions most often asked are in Appendix H.

The interval between interviews was relegated to a minimal role due to the problems associated with this method. Appointments were very difficult to obtain with interviewees, and periods of weeks could pass before a subject finally made himself available. This was compounded by the schedules of the interviewers, both of whom came in from outside the organization to minimize interviewer imposed bias. The results are interesting due to points that are made. However, no analysis beyond reporting and relating them to similar findings through other techniques is appropriate.

It was reported by one or more subjects that addressing and giving the commands is distracting. Many also felt that they do not have enough time to practice using the System to achieve some level of proficiency. This was cited as a major detractor. It was compounded by a manual that was difficult to understand. A table of procedures to follow when difficulties arise would be most helpful. In addition to the lack of user aids in case of trouble, the more sophisticated commands are relatively difficult to learn. Some felt that it was necessary to memorize the commands to be free enough to concentrate on the text at hand. A dramatic problem was that of losing work or files, or being unable to access them. The terminal was also a problem due to confusion about the special function keys, and the differences in conventions among the terminals.

Many indicated a preference for the old ways. As professionals, some indicated that secretaries should do the typing, especially for the first draft. A lack of proficiency at typing is certainly related to this. The structure that the System offers was viewed as a burden, formatting text hierarchically required additional time. This was related to not having a hardcopy to work from.

The most important negative response throughout the study concerned System availability. There were several reasons for this. Early during the period there were too few terminals. Subsequently, there were too few lines for calling into the System. Consistently, there have been numerous crashes resulting in "down-time", a problem that remains.

Down-time is not limited to the System as a whole -- terminals and printers also were reported to fail. Technical problems associated with the use of the printer and its operation were the inability to underline, and the lack of control over what portion of a document is to be printed.

A problem resulting from the experimental nature of the System was noted. Changes are made periodically in the commands and procedures for using AHI, many of which are not announced or documented. This was emphasized as an important change that should be made.

Other suggestions were that privacy should be more secure for working documentation in the System. Although a subject was pleased with the training period, initial sessions should be limited to a smaller and more manageable set of commands.

Positive responses emphasized the communication capabilty and movement through different files. This was a part of the potential that many subjects reported later during the study period when two thirds of the users were accomplishing "all" of their work on it. They found that communication with persons removed from the immediate environment has increased. In particular, several persons on the ARPA Network were contacted and profitable results occurred which would not have been possible.

Most users reported that they could see the potential for increased efficiency. There were some reports of instances where the saving in time was significant. Some felt that there was a liberating effect on their thinking facilitating the restructuring of daily tasks so that they could be efficiently dealt with. The use of the Imlac CRT display was important in positive perceptions, especially for editing purposes. In general, the user population became more positive with experience, and many of the negative comments were not repeated later in the study.

The next section will discuss, summarize, and analyze the results of the combined methodological instruments, with a synergystic outcome -- providing additional insight into the effect of this advanced computer system through the interrelationships and patterns of the data.

Section VI
SUMMARY AND CONCLUSIONS

This study reports the findings encompassing a seven month period during which the AHI System was implemented, users were trained, numerous problems were encountered and overcome, and the organization began to evolve toward an Augmented Knowledge Workshop. In general the study supported the hypotheses and documented the experiences in this first-of-a-kind situation.

Discussion of the Hypotheses

Overall, the study is consistent with the assumption that there would be psychometrically measurable effects on a population due to implementation of the System. It was implicit that these effects would be of a behavioral or psychological nature, and they were. However, the directness of the subjective measures does not permit conclusions of a more profound, philosophical nature. Subjects were commandeered as observers of their own behavior, the depth of which is dependent upon their level of consciousness, and limited to the more practical aspects of impact. The subjects did consider the pragmatic characteristics of the new tool, but the philosophical implications, viewed from this precipice of societal evolution, remained obscured beneath the humdrum and flurry of pedestrian activity.

More indirect probes were not feasible in the non-laboratory environment with limited resources. The Organizational Climate Index was originally intended to ascertain the subtle affective and perceptual fluctuations that should appear if a more profound transformation were to occur, i.e. along the lines that Marshall Mcluhan introduced concerning mass media. The instability of the organization, the methodology itself, and the continual compression of the use time period due to technical difficulties, limited this technique to general population description. The OCI was the only available indirect instrument that the literature search revealed and there were no instruments that were adequately designed. The general attitude questionnaire ("T") did not detect deeper changes in the attitudinal structures which were expected to cause a shift in the overall perception of the technological concepts (see below).

Although a less than desired amount of light was shed upon the theoretical implications of this extraordinary technology, more was uncovered about the hypothesized overt behavioral changes than was anticipated.

Hypothesis One: Effects on the Individual

As hypothesized, the cycle of events to produce written documentation gained flexibilty and was more timely. Increased efficiency permitted the individual to exercise more control over the development of his own ideas on paper and also to be more responsive to the formats and requirements imposed upon him. The fact that one person was able to complete the entire process of publishing a technical paper, from original ideas to typewritten document, dramatically illustrates the impact on routine job behaviors.

That we will ever be able to say that a person was more creative due to some variable, with the confidence of an engineer for example, remains questionable. However, in this case the subjects did state that their thinking was enhanced, that the structure added a new dimension to their thinking, and that the System provided mnemonic assistance. Limitations were more likely to be encountered at the interface between the augmented and non-augmented "worlds" which were not ready to accept new ways of representing conceptual relationships on paper. The interface limitation will diminish in magnitude, but it is representative of the greatest obstacle this technology faces: natural human intransigence.

Hypothesis Two: Effect on Groups

As with the hypothesized effect on the individual, the effect on the communication among individuals was identified de facto, but the identification of better decisions, and qualitative implications in general, remains elusive. While future researchers will wrestle with this methodological problem, we were able to clearly show behavioral changes, not only by subjective judgement and observation, but by counting and classifying communicative transactions. The System was used, it did grow into an interaction network that rivaled the traditional networks, and it did postively affect attitude. The Augmented Knowledge Worker evolved manifesting a dependence on the technolgy, a systematic development of methods for using the System, and a social milieu focused through the System into a Knowledge Workshop. The beginnings of a knowledge economy were detectable as

AKWs were recognized for accomplishing knowledge work where they would not have been, and basic working information was increasingly handled via the System, as Engelbart predicted (see Section 1, p.31).

Hypothesis Three: Effect on the Organization

Having shown that communication channels were rerouted through the System, and that this was perceived as acceptable among groups as an integrated social phenonmenon, little more is necessary to demonstrate effect on the organization. Indeed, vertical communication was faciliated, and inasmuch as the nervous system of an organization is communication among the constituents, the organizational Gestalt must have experienced growth. Management did exercise control in the cybernetic sense through the System of its own volition, and likewise, did receive feedback.

It was demonstrated that smaller organizational units, organizations in themselves, can accomplish the major portion of their business through AHI, with the aura of an Augmented Workshop expanding vertically through four levels of management. But, qualitative implications, no matter how indirect, were not derivable to show the appearance of open management techniques with or without a loss of efficiency. Follow-on studies of this organization may conceivably show more open vertical communication in comparison to this data; however, the methodological roadblock remains: measurement of the efficiency of management. It is analogous to identifying leadership traits, and such other things which are ultimately a function of individual style.

This study encroached upon a most demanding question facing students of organizational behavior: which of the two forces that comprise an organization, the individual personalities, or the structurally imbedded operations, the "system", are more powerful? AHI has been demonstrated to be, as a minimum, a tool for accomplishing the imbedded operations of an organization. But, in relation to all other variables, individual personalities appear to be responsible for the preponderance of influence on the degree to which positive effects can be realized.

Individual Differences

The consistency of the data across the different tests, questionnaires, and observations for individual subjects was of major methodological importance. It also highlights the individual differences variable. An examination of the population profile, both job task type and the demographic factors (see Appendix A), and the System user's scores (see Appendix J) did not reveal any relationships.

It was expected that age, technical specialty, job tasks, and other factors would be associated with a negative set of responses, for example. Although the population size is small, we can be reasonably certain that the population characteristics did not influence the acceptance and utilization of the technology. The question remains, why do the differences detected appear between subjects? The only remaining factor, responsible for score differences of up to three standard deviations, appears to be individual difference.

The administration of a personality inventory was considered initially; however, the resistance of the population to such a test made it prohibitive. The Activities Index (Stern, 1970) is an instrument that potentially could be given early in the evolution of a Workshop for later comparison with the acceptance and utilization of the System for each subject. The strong force that individual personality represents is a delicate area of investigation, but one that must be explored if the System is to be "interjected" into a working environment with a reasonable element of predicted success. The economics of computer augmentation may encourage the utilization of personality testing as a prerequisite for implementation.

Effect on General Attitude Toward the Technology

The test instrument designed to detect the more covert effects that were hypothesized appears to be invalid, an important methodlogical finding. There was no significant difference between the mean attitude of the groups toward the general technology. However, all other findings strongly support conclusions about effects. Therefore, it must be concluded that the test instrument was not sensitive to the effects of the AHI System on this small sample. It indicates that measuring the attitude toward a general technology may not be a reliable method of ascertaining the specific effects on a small population. The consistency between the behavior and the responses to the other instruments did; however, point toward strong reactions to specific aspects of the System.

The Progression Toward Augmentation

There were numerous findings concerning the process of evolution toward full augmentation, which was reached by aproximately 25 percent of the user population at the time this study was concluded.

A great deal of inertia favoring retention of the current modus operandi was found. The routine work methods were ingrained to the habit level, and required some extinction and adaptation during the learning process. This, coupled with the usual "rejection phenomenon," could have prevented transition to augmentation; however, it was possible to overcome these obstacles in this working environment.

Thresholds were discovered that must also be passed during the individual's evolution. Initially, a strong tendency to use the System as an automatic typewriter for text editing was observed for most subjects. After attaining a certain level of usage and proficiency, subjects crossed the threshold to usage for on-line composition.

A marked psychomotor development, System transparency, was concommitant with on-line composition. Subsequent to this development, a threshold in the learning process, the individual dealt with the material and content at hand not burdened with the distracting thoughts about procedure and System operation. This tended to free him for spontaneous, creative work while the rules of operation and syntax remained subliminal in a way analogous to the use of language in conversation. It was noted that the command language is particularly suited to this due to its similarity to natural language. Prior to passing through this threshold, subjects would report a considerable loss of efficiency. When the threshold was passed, it was found that the hypothesized effects were realized for a majority of the population.

The individuals reported and demonstrated increased effectiveness. Effectiveness included an increase in efficiency, which was reported as a reduction in throughput time in this context. However, there was no increase in quality based on subject judgments. Neither was there a loss in quality. The particular test items, which required that the individual evaluate his own work, are probably not a valid indicator. A more indirect instrument, such as a semantic differential, should be considered for future investigations where quality is of interest.

The display subsystem was found to be more desirable than the teletypewriter subsystem. Certain individuals found that it was vastly more effective, and there was some feeling that full augmentation could be realized only through the display subsystem. Its power should be available to all users, and it may actually be easier to learn as indicated by the few subjects who learned to use the display subsystem only.

Proficiency was found to be a function of intensity of use, rather than longevity with the System. All persons motivated to maintain a regular intensity of use were able to become proficient regardless of aptitude or experience. Intensity was necessary to retain skill as well. The proficiency test also showed that an alternative editing technique was more effective: execute edit. Proficiency was closely associated with the learning thresholds to more sophisticated augmentation, positive perceptions of the System, and the amount of communication facility usage.

Effects on Communication

The communication facilities were used with increasing intensity throughout the study period. Of these, Send Message was used most extensively, the Journal a close second, and shared files and linking were used relatively little. The Journal was not used for dialogue support but rather served to send documentation and messages. The positive responses about the effectiveness of the communication facilities corresponded to higher use levels.

AHI did enhance team activities around a common task; however, it did not affect intergroup communication, or engender any positive trend toward more ideal group dynamics. Communication through the System was dependent upon need, much as it is through traditional channels. The scope of the on-line community was important -- a subset of the population did not have as large a group of on-line recipients as others. Some communication increase among peers was related to the "commom enemy" problem, i.e. the System was a challenge to all users generating discussion about common problems.

Some channels were opened with persons who otherwise would not have been contacted. The System provided the informational incentive and made the contact possible. AKWs in general were found to have a broader base of contacts and more timely transactions than the control group.

Recommendations for Augmentation

The more practical findings provided the basis for establishing certain prerequisites that seem necessary for the individual to begin to become an Augmented Knowledge Worker. The prerequisites are based primarily on subject responses, the proficiency exercise, and observation of behaviors. It is recommended that they be met whenever computer systems are to be employed for the daily accomplishment of knowledge work.

The necessary hardware must be avaiable and in dependable operation. The lack of this had a negative effect on those who were trying to learn, under pressure, and particularly those manifesting an attitude below the mean. In a minority of cases this had a strong, deleterious effect. The unavailability of terminals and the inoperative printer were cited most often as negative factors. System down-time remained a major obstacle throughout the period, even though down-time is characteristic of experimental systems. At least every effort must be made toward System availability at predetermined times.

Introductory and self explanatory documentation is necessary. The lack of a reference manual and a "what to do in case of" trouble manual posed significant problems initially. The number and variety of operational difficulties and failures require that an extensive reference manual be made available at the outset of usage. Many of these problems, it should be noted, were with the ARPA Network and involve retaining a connection to the System mainframe.

Training could help solve this problem and could relieve much of the initial frustration that was noted. Supported by reference materials, small classes, and a structured course, training could speed the individual's progress. It was found that highly motivated subjects could learn with minimal training; however, the negative reactions of others were prohibitive in some cases.

Training must include some indoctrination about the purpose and definition of the System. It was found that a minority of the subjects understood the concept of full augmentation, which appears to be necessary to realize the full System potential for any individual. Experience with previous computer technology interfered with this understanding, limiting usage to text editing in some subjects.

It was demonstrated that consistent effort is required to become proficient on a basic level. Those subjects who had lapses in use exceeding a week were markedly less proficient than subjects with similar "longtensity". Some of this problem would be alleviated by alloting a specific daily time period for practice.

The sphere of available support personnel for the individual was found to be very influential. For individuals who responded most positively, this was found to be composed of managers also who were users, and people to help, advise, console, inform, repair, maintain, etc. Positions should be established to ensure that persons are responsible for the hardware, software, and training, particularly keeping users informed about changes in command language and other operating functions.

Standard operating procedures were found to be necessary to establish what tasks should be done on the System, and the structure and methods for accomplishing these tasks. Additional research will probably be necessary to establish these procedures and answer some of the questions raised.

Recommendations for Further Research

There is a high probability that attitude will be an indicator of System effectiveness for a prospective individual user. Those subjects whose responses to questions about effectiveness, anticipated attitude and retrospective attitude were significantly below the mean, also did below average on the proficiency test (see Appendix J). Although it was not statistically significant, the general attitude toward the technology was also lower for these subjects and for those who were scheduled to be users but never initiated use beyond the training sessions. Thus, attitude pretesting as well as testing individual differences (discussed above) could conceivably be employed in a requirements analysis to determine AHI's applicability in another environment.

Personalities are such a significant factor in System use, as discussed above, that extensive investigation correlating personality with System utility would be of great value. In this specific case, the OCI should be given in one to two years to ascertain the effects on organizational climate, which is based on aggregate interactions of personalities and their environment. It should be noted that it is not necessary to compile data on individuals if this is offensive.

The Communication Tally analysis should definitely be posttested. The time frame should be similar to that for the OCI; however, it is necessary that the entire, expanded population pass the communication threshold. It is at this point, where the individual has experienced on-line composition, System transparency, and has a substantial on-line community, that we can quantify his communicative behavior with valid results. To wit, the examination would be of the true AKW.

Overview

The qualitative aspects of the hypothesized effects were not entirely substantiated; however, they may be with additional time, methodological research, and System development. As this study shows, the population experienced an unprecedented flexibility and involvement with textual information through the utilization of powerful augmentation tools.

The tools facilitated the construction of a dynamic information space which was shared with the on-line community. The communication facilities were employed to create new patterns of communication that would not have been attained through alternate means. The resultant, documented team collaboration extended to the organization. Vertical communication was modified, as new channels were opened and formal channels were altered from the traditional patterns.

The subjects' experience was analogous to traveling through the dynamically structured information space of a geographically distributed community of knowledge workers with such rapidity and ease that it was almost addictive. The dramatic changes in the work methods and communication within this population, in the time span of seven months, indicates that Peter Drucker's "knowledge revolution" will arise from the use of systems such as AHI. At least for a population of government scientific and engineering personnel, AHI's potential is beginning to be realized as that which its designers at SRI intended: a revolution in the communication process in the broadest sense.

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APPENDIX A

POPULATION PROFILE DATA

SUBJECTS	JOB TASKS*										DEMOGRAPHIC FACTORS			
S	1	2	3	4	5	6	7	8	9	10	SER	AGE	POST	RANK
USERS 1														
1	0	10	0	0	10	5	55	10	10	0	20	42	SECCHF	14
2	0	50	20	0	5	0	0	5	20	0	8	29	EE	11
3	0	0	0	0	20	0	30	50	0	0	23	45	PRGADM	11
4	5	15	20	0	15	5	25	0	15	0	24	47	PHYSCI	14
5	20	5	20	5	10	5	5	5	20	5	6	31	EE	12
6	0	45	12	5	10	2	0	1	25	0	11	31	EE	12
7	10	70	5	0	5	5	0	0	5	0	17	37	EE	13
8	50	5	10	0	5	5	0	5	20	0	6	29	EE	CAPT
9	0	0	0	20	0	0	0	30	0	50	14	43	CLKTYP	4
USERS 2														
10	0	10	65	5	3	5	0	0	12	0	15	38	EE	13
11	0	15	25	20	3	2	5	15	10	5	6	29	PSYC	CAPT
12	60	20	0	0	0	5	0	5	10	0	11	35	RESPHY	12
13	25	25	10	10	10	5	0	5	10	0	7	29	EE	12
14	15	45	5	15	5	5	0	5	5	0	3	25	EE	9
15	0	20	40	0	10	5	5	5	10	5	12	33	EE	13
16	5	5	10	0	20	4	35	1	20	0	29	51	BRCHF	15
17	50	10	10	10	5	5	0	0	10	0	27	55	RESPHY	12
18	10	2	2	10	1	1	0	1	72	1	3	25	EE	9
37	0	10	10	10	10	10	10	10	30	0	23	54	PSYCH	14
38	5	10	10	0	30	0	40	0	5	0	20	43	DCHF	COL
39	0	0	0	0	0	0	90	5	5	0	20	55	DCH PL3	13
NON-USERS 1														
19	29	15	15	3	2	0	5	6	25	0	18	40	MATH	13
20	10	40	10	0	5	0	5	10	20	0	6	28	EE	12
21	29	5	15	5	5	5	20	1	15	0	15	41	RESPHY	12
22	1	20	5	5	8	1	40	15	5	0	28	47	SECCHF	14
23	25	4	1	25	0	0	0	5	40	0	11	33	ABRCH	MAJ
24	3	64	0	0	2	0	0	1	30	0	2	24	PRENG	LT2
25	60	5	0	20	0	0	0	5	10	0	12	35	EE	12
26	10	20	10	30	5	0	5	10	5	5	12	35	EE	12
27	55	1	1	20	1	5	1	1	10	5	16	38	MATH	12

```
NON-USERS 2
28 20   15   10   40   5    1    0    2    5    2    16   39   EE     13
29 40   0    10   40   5    1    0    2    5    2    21   45   MATH   13
30 10   35   0    10   5    0    0    40   0    0    2    29   EE   CAPT
31 20   10   10   20   0    0    10   10   20   0    25   45   PHYSC 13
32 13   2    20   0    15   0    20   5    25   0    13   38   RESPH 13
33 50   0    0    15   0    0    0    15   20   0    2    26   AENG SGT
34 0    40   15   5    10   5    0    0    20   5    11   34   EE     13
35 10   20   25   0    5    0    0    5    30   5    8    56   EE    LT1
36 0    0    0    5    15   0    0    20   0    60   11   33   CLKTYP 3
```

SERV = government service time in years
RANK = Civil Service level or rank if military
POST = Position if a manager, or specialty if technical

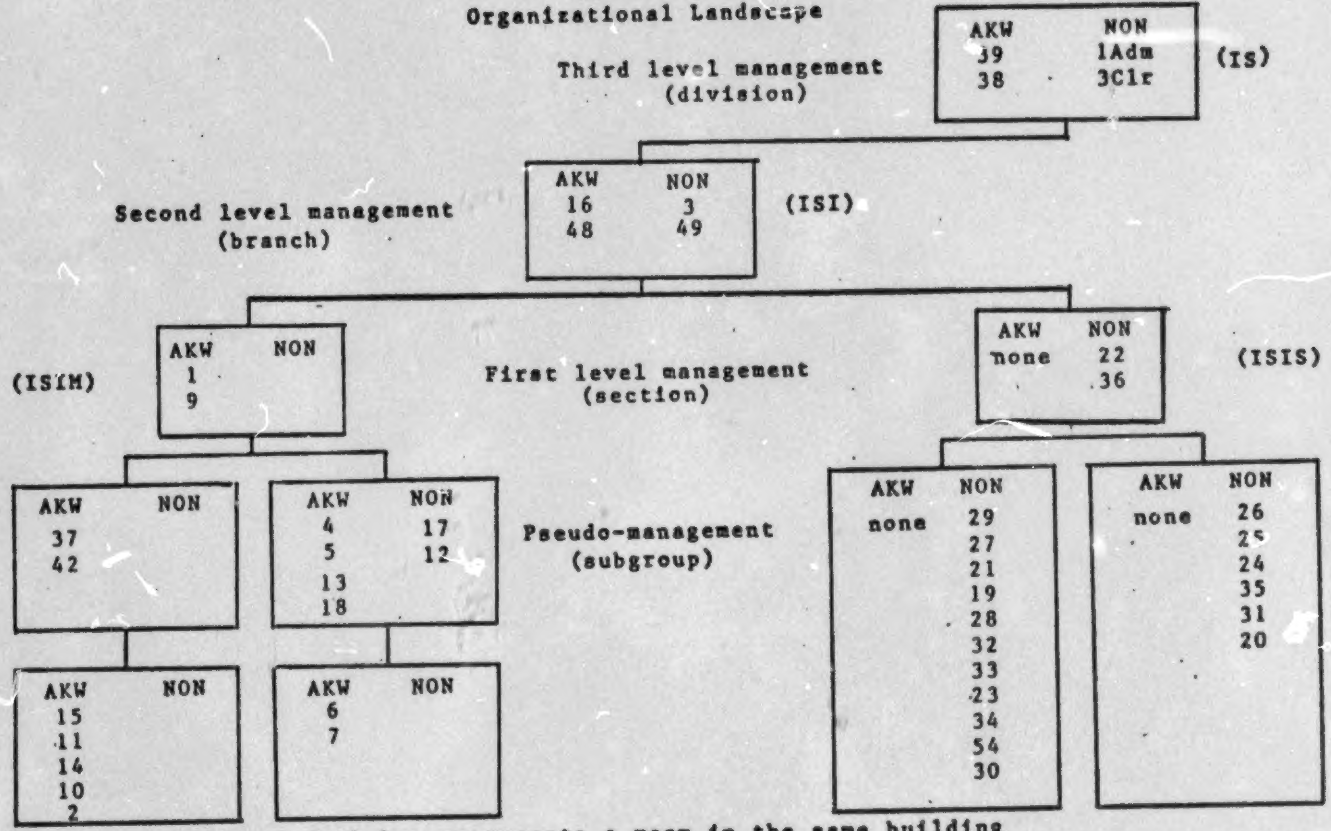
EE = Electrical Engineer
PHYSC = Physical Scientist
RESPH = Research Physicist
CLKTyP = Clerk Typist
PRENG = Project Engineer
PSYC = Psychologist
PHYSC = Physical Scientist
PRGADM = Program Administrator
AENG = Assistant Engineer
MATH = Mathematician
DCHF = Division Chief
BRCH = Branch Chief
SECCH = Section Chief

AGE = in years

*Job Task Types (general categories of job activities that are accomplished by the population):

1 = Programming
2 = Project engineering, including:
contract paperwork (forms memos, etc.),
reviewing proposals and reports
3 = Writing plans and/or reports
4 = Software operation (incl. evaluation, debugging of software packages)
5 = Briefings
6 = Demonstrations of systems
7 = Managing other personnel
8 = Administrative paperwork
9 = Study, review of the state-of-the-art, reading, literature search, etc.
10 = Secretarial work

Appendix B
Organizational Landscape



Each box represents a room in the same building

Appendix C

Attitude Questionnaire ("T")

Instructions: Place a pencil mark in the place on the answer sheet that most accurately represents your position. Please answer ALL questions.

1. In general, automation is a good thing.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

2. Automated libraries are extremely useful because of the information explosion today.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

3. A computer based library for retrieving all information that I use in my daily activities would be a useful aid to me.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

4. I do not enjoy working with computers.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

5. I would not trust computer storage of paperwork that I use daily.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

6. In general, computers are reliable.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

7. Computers can save a lot of personnel time when applied to daily work.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

8. If a program were written and deployed to handle my daily paperwork it would be of tremendous advantage.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

9. Privacy cannot be maintained for information stored in computers.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

10. I would not be bothered by a lack of privacy if I used a computer for all my daily paperwork (i.e. my fellow workers would have access to all my written work).

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

11. I would not mind entering all my written work into a computer system for future use by myself and access by all other persons using the system.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

12. I think that handwriting work for typing or for my own personal use on the job is a primitive method of doing things.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

13. I would find it advantageous to be able to store and then retrieve for future use, paperwork and other written material of routine value to me.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

14. A software system that would essentially replace the paperwork activities of my secretary would not be a significant improvement over the present situation.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

15. Typing my own paperwork into a computer system would bother me.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

16. Computers are excellent for programming and subsequent processing of programs.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

17. Computers are excellent for loading, storing, and manipulating textual information (eg. letters, plans, reports, etc.).

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

18. Computer technology is not at a point where it can provide a service to non-programming personnel through the use of on-line terminals.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

19. Thinking could be aided through the use of an on-line computer system given the appropriate software.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

20. A computer system that was installed here to be used in place of pencil and paper would receive excellent acceptance.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

21. The average person does not have the patience to use a computer to accomplish jobs that have due dates.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

22. Most errors in the operation and service of on-line systems are due to human error.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

23. A person must have a sound basic understanding of computers to use even the most elementary program with success.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

24. I think it is much better to enter text into a computer where it would be available for revision rather than having a secretary type a new copy every time revisions are made.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

25. Using a computer as the medium through which to interact during conferences would not be an advantage over direct interaction without computer assistance.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

26. Having a computer terminal at my desk for use at my convenience would be tremendous.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

27. Text editing is an excellent application of computer technology.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

28. With the great complexity of problems today the decision maker could well use a computer (appropriately programmed) to present his thoughts to others.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

29. Meetings would be greatly facilitated by having an agenda displayed on a TV-like on-line terminal.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

30. Using a TV-like terminal as a "blackboard with memory" during meetings would increase the productivity of the meeting significantly.

(a) strongly agree (b) agree
(c) disagree (d) strongly disagree

Appendix D

T Questionnaire Subject Scores

Group	Subject	Pretest		Posttest	
		raw score	z score	raw score	z score
Experimental I & II	01	71	-0.68	64 u *	-1.85
	02	76	0.45	73 u	-0.44
	03	74	0.0	76 d	0.04
	04	65	-2.02	71 d	-0.75
	05	72	-0.45	75 d	-0.12
	06	80	1.35	89 d	2.08
	07	80	1.35	76 u	0.04
	08	76	0.45	79 d	0.51
	09	72	-0.45	79 d	0.51
Control IV & V	19	58	-0.92	59 d	-1.34
	20	55	-1.44	68 d	0.02
	21	62	-0.22	63 d	-0.73
	22	65	0.48	74 d	0.93
	23	67	0.65	61 u	-1.04
	26	62	-0.22	72 d	0.63
	54	82	no data	78 u	1.53

* u=shift up from pretest, d=shift down

Appendix D (continued)

T Questionnaire Subject Scores

Group	Subject	Pretest		Posttest	
		raw score	z score	raw score	z score
Experimental 2 III	10			69	-0.02
	11			53	-2.12
	12			72	0.38
	13			80	1.43
	14			76	0.91
	15			73	0.51
	16			64	-0.67
	17			72	0.38
Control 2 VI	28			73	-0.31
	29			77	0.22
	31			79	0.49
	32			69	-0.85
	33			61	-1.93
	34			76	0.09
	35			72	-0.45
	46			83	1.03
	25			88	1.70

Appendix E

Content Questionnaire (and percentage distributions)

QUESTIONNAIRE ("Q") ON THE USE OF THE AUGMENTED HUMAN INTELLECT SYSTEM: We need to know your specific opinion of AHI to help us determine its effectiveness. Try to allow for the fact that the System has been experimental and will not become a service until the Fall when the Utility is available.

INSTRUCTIONS: Please rate the appropriateness/correctness of each statement by selecting the best answer and marking it with pencil on the answer sheet provided. Answer ALL questions. Comments on each of the questions are welcome.

1. The AHI System is everything it was supposed to be.

6	35	53	6	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

2. The more I use the AHI System the more I like it.

23.5	53	23.5	0	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

3. The total throughput time for my typing (time to final copy) is substantially less with the system (given everything is running).

12	53	17.5	17.5	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

4. I have used pencil and paper much less since I learned how to use the AHI System.

6	47	29	18	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

5. The only reason I would not use the AHI System is because I do not have material to be written/prepared.

0	29	18	47	6
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

6. I believe that my work is of higher quality than it was prior to the installation of the AHI System.

18	6	76	0	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

7. I think I am more efficient and therefore accomplish more in the same period of time than I did before the AHI System was installed.

18	29	35	18	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

8. My experience has been limited so far, but I expect that my opinion will be more positive with additional usage.

18	53	23	6	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree

9. The AHI system is an advance in the state-of-the-art.

18	59	23	0
(a) strongly agree	(b) agree	(c) neutral	(d) disagree
0			
(e) strongly disagree			

10. I think AHI will improve my effectiveness in almost everything I do that is job related.

6	41	41	12
(a) strongly agree	(b) agree	(c) neutral	(d) disagree
0			
(e) strongly disagree			

11. It is unnessary to write out anything when the AHI system is available except for things like routine forms.

0	29	24	47
(a) strongly agree	(b) agree	(c) neutral	(d) disagree
0			
(e) strongly disagree			

12. AHI will result in increased effectiveness for anyone who uses it to accomplish his paperwork activities.

6	53	29	12
(a) strongly agree	(b) agree	(c) neutral	(d) disagree
0			
(e) strongly disagree			

13. After a reasonable amount of training the average person can use AHI with relative ease.

18	70	6	6
(a) strongly agree	(b) agree	(c) neutral	(d) disagree
0			
(e) strongly disagree			

14. The system is effective for all the kinds of tasks I perform on the job.

(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree
0	29	24	41	6

15. AHI enhances my ability to think about the written work I am doing on the system.

(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree
12	47	23	18	0

16. File sharing (reading and/or writing on others files) is an effective way of keeping informed.

(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree
41	47	12	0	0

17. The Send Message feature has been a useful tool for communicating with other users.

(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree
18	29	47	6	0

18. I have been able to interact with other users more readily, despite geographical distance in some cases.

(a) strongly agree	(b) agree	(c) neutral	(d) disagree	(e) strongly disagree
18	18	53	12	0

19. Better training and/or training materials would have improved my opinion about AHI.

24 (a) strongly agree
53 (b) agree
18 (c) neutral
6 (d) disagree
0 (e) strongly disagree

INSTRUCTIONS: Please select or provide the best answer and mark it on the answer sheet.

20. Which terminal device do you find the most effective to use?

41 (a) execuport
47 (b) IMLAC CRT
(c) IBM Selectric
(d) teletype
(e) other--specifiy

21. What percentage of the time is a terminal available for use?

53 (a) 80-100%
6 (b) 60-79%
12 (c) 40-59%
12 (d) 20-39%
18 (e) less than 20%

22. What percentage of the time is the AHI system availabe for use to you if all hardware is up?

41 (a) 80-100%
24 (b) 60-79%
18 (c) 40-59%
12 (d) 20-39%
6 (e) less than 20%

23. How many hours a day on the average do you use the AHI System?

29 (a) less than 1
29 (b) 1-2 hrs
24 (c) 2-3 hrs
18 (d) 3-4 hrs
0 (e) more than 4 hrs

Appendix F: Contingency Tables, Content Questionnaire ("Q")

#8

SA	A	N	DA	SDA
1	11			
11	11111	1		
1	11	11		
		1		

SA - Strongly Agree

A - Agree

N - Neutral

DA - Disagree

SDA- Strongly Disagree

#7

SA	A	N	DA	SDA	
11					SA
1	1111	1111			A
		11	1		N#3
	1		11		DA
					SDA

#2

#3

	SA	A	N	DA	SDA
SA		1			
A	11	11111	1		
#4N		111	1	1	
DA			1	11	
SDA					

Appendix G

Proficiency Exercise (TNLS)

INSTRUCTIONS: We would like you to create a file called EXERCISE, Copy all of the file called copy from the RADC directory into it, and then edit it to look like the clean version that follows. At the same time we would like to have you answer the questions that are posed. Wherever question marks appear (?) fill in the appropriate number for you. Where dashes occur -- substitute an X for the set that best indicates how you feel. Thank you for your cooperation. As soon as you begin, type a control T to record the computer time on your hardcopy (in addition to the clock time that you record manually).

To accurately record the time necessary to complete the entire exercise, type a "control T" before you create the EXERCISE file and after you complete the last exercise item.

We would like to know what commands and procedures people are using to accomplish tasks like this exercise. This will help us in the training sessions for the next group as well as give us some insight into what parts of the AHI language you are the most comfortable with. To aid us in this please give your Execuport hardcopy of this exercise to either Bair or Stone.

UNEDITED TEXT that is in (RADC,COPY,):

We would like ya to do some spAcific things with the following information to see how efficiently ya operate in the ahi system. i hope the instructions are sufficiently clear so ya will have no difficulty inunderstanding what ya are to do. this exercise was gexported on the execuportterminal. There are no correct answers to any of the questions, but we do to want get yar general feelings-. try and wrok as rapidly as is comfortable for ya. if ya have time interruptions please not they. (Continue to read the instructions, then come back and replace the dashes with an X at the appropriate answer.)

I have been using the ahi system for -- months.

when i am writing or editing a manuscript i feel very comfortable with the ahi language.

--strongly agree --agree --neutral --disagree --strongly disagree.

why?

the ahi system is helpful in myeveryday work.

--strongly agree --agree --neutral --disagree --strongly disagree.

time started (?)

time completed (?)

CLEAN VERSION:

We would like you to do some specific things with the following information to see how efficiently you operate in the AHI system. I hope the instructions are sufficiently clear so you will have no difficulty in understanding what you are to do.

This exercise was generated on an execuport terminal. There are no correct answers to any of the questions, but we do want to get your general feelings. Try and work as rapidly as is comfortable for you. If you have time-interruptions please note them.

Time started: (?)

I have been using the AHI system for (?) months.

When I am writing or editing a manuscript I feel very comfortable with the AHI command language.

--strongly agree --agree --neutral --disagree --strongly disagree.

Why?

The AHI system is helpful in my everyday work.

--strongly agree --agree --neutral --disagree --strongly disagree.

Time completed: (?)

FURTHER INSTRUCTIONS:

Now find out who is on the system, link to either Bair, Stone, Kennedy or Mcnamara and ask them for some relevant information (time, when is next meeting, etc.).

Now send the completed file to Bair using the Journal System.

Send a message to Bair stating that you have finished the exercise and are sending him the completed file via the Journal System.

THAT'S IT!!!! YOU HAVE JUST STRUCK ANOTHER BLOW FOR 1984...

Appendix H

Interview Procedures

Subjects' impressions of the AHI System were obtained through unstructured interviews of trained users. The situation was informal and interviewing took place at each subject's desk.

The interviewer's introduction was brief. Subjects were told that their impressions of AHI were going to be recorded, as would later impressions, in order to help establish the effect of AHI. Subjects understood that all new users of the AHI System were also to be included in this study.

If any subjects had difficulty in responding, they were then prodded with questions (see list). The tendency for most was to give a positive or negative short response.

Questions were not read to the subjects, but rather were presented in conversational form. A minimum of questions were asked in order to prevent unduly structuring the interview. Some questions were modified to suit the person, situation, or conversation. Occasionally, questions needed to be reworded for a subject's comprehension.

All responses were accepted. No disapproval was shown on the part of the interviewer. At times a subject was asked to clarify his response. Most subjects seemed at ease because they were acquainted with the interviewer and the studies being done relating to AHI.

Questions that were used:

What do you feel are the good and bad points of AHI?

Do you find the AHI System is efficient for you to work with?

Was the training time on the System sufficient?

Do you feel you get enough practice on AHI?

Do you plan to use the AHI System for your work?

Do you like the Execuports?

Do you foresee any problems in using the System?

What is hard to learn/understand about AHI?

Comment about the reliability of AHI.

Comment about AHI's TNLS manual.

Do you use the Send Message?

Does Send Message enable you to communicate effectively?

Do you ever link with another user for communication?

Do you prefer the Send Message to off-line inter-office memorandums?

Do you write any letters with the AHI System?

Does the Journal System help you to work more efficiently?

For what type of work do you use the AHI System? In what ways?

Do you prefer to do paperwork off line? Why?

Do you find sharing another person's files valuable or useful?

Do you like other people being able to read your files?

Do you find file sharing an asset of AHI?

Would you rather use pencil and paper than the AHI System? Why? For what?

In your opinion what are some of the best and worse features of the AHI System in relation to its efficiency, commands, and Viewsystem?

What do you feel are some of the main problems of the AHI System?

Under what conditions would you be inclined to use the AHI System more?

Would you use AHI more often if it were more reliable?

If you had your own terminal would you use AHI more often? Would you want your own?

If you had better command of the System would you use it more often?

Is the manual/training specific enough?

Do you think the Journal System lacks any necessary features?

Do you outline more when you use AHI to write a paper?

Does it take you less time to do your work when you use the AHI System for paperwork?

Have you had much practice with AHI?

How often do you use AHI? Regularly?

Are System's commands hard to retain after a few weeks? Would a review sheet help?

Do you prefer any other computer System that you have been exposed to?

Are you familiar with any other subsystems of AHI besides Send Message and Journal?

Appendix I

INSTRUCTIONS FOR THE COMMUNICATION TALLY SHEET

What is tallied? The following interpersonal contacts (communications) are to be tallied.

1) All telephone calls,
2) All personal (face-to-face) oral communication (formal or informal, except for exchange of greetings),
3) All paper matter - letters, memos, requisitions, reports, periodicals, instructions, etc.; each batch from one source is considered as one contact regardless of the number of pages.
4) All communication events (except for meetings and interactions on AHI) are further sub-divided into three time classifications: less than 3 mins., 3 to 15 mins., and longer than 15 mins. These time divisions refer to the elapsed period of time spent engaged in the communication event - reading, writing, speaking and/or listening.
5) Formal meetings will be recorded only by the person calling the meeting, and the memo used to call the meeting can be forwarded rather than having to record each attendee on the tally sheet.
6) Paper matter is divided into two categories. One concerns paper that is generally addressed and does not demand the attention of any particular recipient. The other involves communications that are addressed specially to the recipient and require his attention.

How is the tallying done?

1) After you have engaged in a phone call, a face-to-face interaction, or with paper matter, first record the name or names of the other parties involved on the left-hand side of the tally sheet. If a person has already been listed on your tally sheet, you need not do so again. You merely record the second and third communications opposite his name in the appropriate column.
2) Please identify the persons unambiguously so that he or she cannot be confused with anyone else.
3) To the right of the person's name with whom you communicated, search for the appropriate column according to the mode of communication and the elapsed time of the event.
4) If you initiated the communication, mark an "I" in the appropriate column. If you received, or at least did not initiate the event, mark an "R" in the appropriate column. Note, each communication event should be recorded with either an I or an R. If in doubt about who initiated the communication, use your best judgment, but please record it.
5) If there are not enough rows on your tally sheet for a given day, please get another tally sheet from your representative.

ABSENCE: If you are absent from your job either because of a business trip, illness, or holidays, the fraction of the day that you are gone (1/4, 1/2, 3/4, 1) should be recorded at the bottom of the tally sheet.

Remaining questions should be directed to the representative who distributes and collects your tally sheets each day, or to Dr. Conrath or Capt. Bair who can be reached at ext. 3957.

Appendix I (continued)

Name

COMMUNICATION TALLEY SHEET

Date

People with whom you communicated	Telephone Calls			Face to Face				Communication on AHI				Paper					
				Interactions			Meetings					Generally Addressed			Individually Addressed		
	Shorter than 3 minutes	3 to 15 minutes	Longer than 15 minutes	Shorter than 3 minutes	3 to 15 minutes	Longer than 15 minutes		Shared Files	Journal	Snd Mess	Link	Shorter than 3 minutes	3 to 15 minutes	Longer than 15 minutes	Shorter than 3 minutes	3 to 15 minutes	Longer than 15 minutes

Time absent from work (leave, TDY, etc.) on this date:

Put an I for Initiated Communications
R for Received

Appendix J
Test Data Summary for System Users

S	T Quest.		Q Quest.			Proficiency Test						
	Z Scores*		Fac A	Fac E	Z score	#	Time		Variables*			
	Pre	Post	Sum	Sum	Total	Inst	Mins	Rank	A	B	C	Rank
1	+0.68	+1.85	7	12	1.00	126	66	8	12	3	36	5
2	-0.45	+0.44	7	8	-.44					3		
3	0.0	-.04										
4	+2.02	+0.75	4	4	-1.88							
5	+0.45	+0.12	6	7	-.77	155	74	9	8	1	8	8.5
6	-1.35	-2.08	3	5	-2.11	181	141	10	4	1	4	10
7	-1.35	-0.04	5	9	-.11	48	34	3	9	2	18	6.5
8	-0.45	-0.51	7	9	-.11					2		
9	+0.45	-0.51	4	10	-.66					1		
10		+0.02	6	13	.77	64	48	4	24	2	48	4
11		+2.12	5	16	2.00	114	21	1	29	4	116	1
12		-0.38							0			
13		-1.43	6	9	-.22					2		
14		-0.91	7	9	0	83	53	6	21	3	63	3
15		-0.51	6	13	.77	115	22	2	28	4	112	2
16		+0.67										
17		-0.38	6	11	.11					1		
18		-0.80	6	12	0	257	63	7	3	2	6	8
37		-1.01	5	11	.66	110	49	5	6	3	18	6.5
48			8	15	1.00	108	38	2	2	4	8	8.5

*A = Longevity in months B = Intensity category C = Longtensity
*Polarity has been reversed to be consistant with other test scores.

Appendix K

The Limits of Experimental Control: Reorganization

The population membership was originally determined by the organizational structure at that time (over a year ago). It was not expected that there would be any major changes other than attrition and a few transfers. However, this has not been the case and this appendix will deal with the exceptional events that occurred and the implications thereof.

Section II of the report deals with the special attention given to the nature of the population as a whole, and the comparison of the control and experimental groups. A great deal of care was exercised to insure that differences based on organizational structure (especially manager characteristics), demographic data, and the kind of jobs performed by the respective groups were not significant, or if they were, that this was clearly established for the data analysis. The checks that were made, including the OCI and the Job Task Type, showed that the population was essentially homogeneous with a few exceptions such as slightly more programming in the control group job profile.

However, a reorganization was directed by management approximately six months after the introduction of the system to the user group (approximately one month before the posttest was given.) Management was not changed, but a number of the subjects at the basic level were moved, while new individuals were brought in. Fortunately, only one subject in the user group was moved. Several individuals were brought into the user organizational unit posing a problem experimentally: these subjects were simply not included in the controlled questionnaire ("T") population. The subject who did leave was given the posttest at his new location where his job had not substantially changed. (The "Q" content questionnaire was given to all users, however, including those who were moved into the user group. This is not confounding because the "Q" was a posttest only.)

Eight members of the control group were transferred to new locations within the same Division (see the organizational landscape) and 3 departed entirely. An attrition level of three (about 15%) is reasonable with the time period of several months, and is less than expected. The loss lessened the significance of the statistical analysis, particularly for the t tests; however, the analysis was still feasible.

Compensation for the transferred subjects offered little problem. It simply involved giving them the posttest at their new location. Little change was noted in the overall job situation. Since the change was late in the experimental period, even less probability of spurious effect exists for the controlled portion of the study. Any effect would be in attitude toward the organization, to which the "T" questionnaire is not sensitive.

The communication tally analysis was not affected because of the nature of the instrument. The tally was done after the reorganization, with sufficient time for communication patterns to settle. There were a large number of different subjects for this analysis than for the "T" questionnaire. Those subjects who used AHI for communication purposes were the same, while the non-user portion of the population remained in the immediate vicinity. Thus, the validity of the comparison between the system users and a like control group in terms of communication patterns was unaffected by the reorganization. The only comparison affected would be that between the control group in the "T" questionnaire and the control group for the tally method, which is not meaningful because the group membership is substantially dissimilar. The comparison of concern is not affected -- it involves the differences in communication patterns between a group using the system and a like unit not using the system.

It can be safely concluded that for the purposes of this study, no significant spurious effect resulted from the reorganization.